/AZ- SPS-5

**NICHOLS
CONSULTING
ENGINEERS, Chtd.**

November 13, 1996
File: 800.12.2.9.10 0405

Mr. Monte Symons
FHWA
LTPP Division, HNR-40
Turner Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101

RE: Arizona SPS-5 Construction Report

Dear Monte:

Enclosed is the Arizona SPS-5 construction report which was compiled by Arizona DOT. Since ADOT completed their report prior to the region developing one, and since we were given the opportunity to review, we have not duplicated the effort to develop an additional report.

We trust you will find this report to be satisfactory. Mr. John Miller will receive a copy via this letter as well.

If you have any questions or comments, please let us know. Development of the other reports are in progress and they will be submitted as they are ready. Target time frames for the submission of all construction reports is January 4, 1997.

Sincerely,
NICHOLS CONSULTING ENGINEERS, Chtd.

Douglas Frith

Douglas Frith
Co-Principal Investigator

DF/cac
Enclosure

cc: Cal Berge
John Miller

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SPS-5: REHABILITATION OF ASPHALT CONCRETE PAVEMENTS

Construction Report

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ABSTRACT

Eleven test sections were constructed by the Arizona Department of Transportation (ADOT) as part of Strategic Highway Research Program (SHRP) Specific Pavement Studies (SPS)-5 experiment. The SPS-5 addresses the rehabilitation of asphalt concrete pavement. The test sections are located on the travel lane in the east-bound direction of Interstate-8 in south-western Arizona between M.P. 159 and M.P. 161. The rehabilitation strategies on eight SHRP sections included minimum and maximum surface preparation, different overlay thicknesses, and the use of virgin and recycled materials. The minimum and maximum surface preparations were achieved by milling existing pavements to maximum depths of 1 inch and 3 inches respectively. The overlay thicknesses varied from 2 inches to 5 inches. In addition, ADOT built two more sections as part of its own experiment with recycled overlay and asphalt rubber asphalt concrete (ARAC). The first section used a so-called "inverted" design in which a 3-inch recycled overlay was placed over a 4-inch virgin asphalt concrete layer. The test section was 500 feet long. The second section was designed to have a 2-inch overlay of asphalt rubber asphalt concrete (ARAC). This test section was 600 feet long. A 500 feet length of the existing pavement at the eastern end of the test sections was designated as the "control section" for the SPS-5 experiment.

The test sections were constructed in the Summer of 1990 without any major difficulty. Remilling was required on several test sections to ensure proper milling of the wearing course on the minimum surface preparation sections. The paving met the SHRP requirements for asphalt concrete production on all sections. Compacted density problems were encountered on the left lanes of two sections only. The initial cost of construction of the 2-inch ARAC overlay was almost the same as the 5-inch recycled overlay.

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INTRODUCTION

General

As the nation's highway infrastructure is growing older, reconstruction and rehabilitation of the vast road network have become increasingly important. Today, a major share of highway funds is being used up in maintenance, rehabilitation and reconstruction of the pavements. In 1985, it was estimated that four hundred billion dollars will be spent on replacing and rehabilitating existing pavements around the nation over the next fifteen years (1). The costs to the road users of poor pavement conditions will probably be several times this amount in the same period. The Strategic Highway Research Program (SHRP), a five year, $150 million result oriented research effort was initiated in 1987 in order to cope with the rapidly deteriorating highway infrastructure of the nation. The program was authorized by the U.S. Congress with the passage of the Surface Transportation and Urban Relocation Act in 1987. SHRP is a highly focussed research program directed at four specific technical areas: Pavement Performance, Asphalt, Highway Operation, and Concrete and Structures. Research in Pavement Performance is being conducted by SHRP and SHRP contractors in cooperation with the States and the Federal Highway Administration. Although current funding for this research is for five years, the program is designed as a twenty year program. As such it has been named the Long Term Pavement Performance (LTPP) Study.

SHRP's LTPP program is designed to develop better and longer lasting pavements. To accomplish this SHRP will test and evaluate approximately 800 in-service pavements and 1100 newly surfaced pavements constructed as test sections. The LTPP program will evaluate pavement performance over a broad range of materials, pavement types, climates, traffic loadings, subbases, and pavement ages. The LTPP program is focused on two major areas of study. The first study area which evaluates the performance of existing pavements is known as the General Pavement Studies (GPS). The second area which investigates the performance of pavements constructed as part of an experiment is the Specific Pavement Studies (SPS). The SPS projects are aimed at attaining LTPP objectives which cannot be completely met by the GPS studies, simply because existing pavement sections do not provide all the necessary comparisons to evaluate the dominant factors in pavement distress and performance. With greater experimental control, SPS can provide much more precise answers for pavement design and performance prediction. The SPS program presently consists of seven programs grouped into three categories. It will eventually consist of ten programs grouped into five categories as shown below:

CURRENT:

Structural Factors:

SPS-1: Strategic Study of Structural Factors For A.C. Pavements

SPS-2: Strategic Study of Structural Factors For Concrete Pavements

Pavement Maintenance:

SPS-3: Preventative Maintenance Effectiveness of Flexible Pavements

SPS-4: Preventative Maintenance Effectiveness of Rigid Pavements

Pavement Rehabilitation:

SPS-5: Rehabilitation of Asphalt Concrete Pavements

SPS-6: Rehabilitation of Jointed Portland Cement Concrete Pavements

SPS-7: Bonded Concrete Overlays of Concrete Pavements

FUTURE:

Environmental Effects:

SPS-8: Study of Environmental Effects in the Absence of Heavy Loads

Materials Validation Testing:

SPS-9: Asphalt Concrete Materials

SPS-10: Portland Cement Concrete Materials

This report discusses the construction of test sections for SPS-5: Rehabilitation of Asphalt Concrete Pavements.

Problem Definition

Many highway agencies in the United States and Canada are faced with the difficult task of determining the best way to treat existing aging and deteriorating asphalt concrete pavements. The type and timing of rehabilitation measures are the prime concerns for rehabilitating asphalt concrete pavements.

Asphalt concrete overlays are the most widely used method for rehabilitation of asphalt concrete pavements in the United States. Pavement surface preparation and type and thickness of overlay are the most important details of such rehabilitation methods. Thus, determining the effects of these details on pavement performance under a variety of climatic and existing pavement conditions is an area of urgently needed research that will help develop improved rehabilitation design procedures. This will accomplish one of the major objectives of LTPP research program.

A generally accepted approach for evaluating pavement maintenance and rehabilitation alternatives is the use of pavement management concepts including life-cycle cost analyses of construction and rehabilitation alternatives (2). The ability to predict the performance and life expectancy of various rehabilitation strategies, with and without overlays, is essential to pavement management and life-cycle cost analyses. Thus, development of improved performance prediction models for various rehabilitation strategies is essential to achieving LTPP objectives.

Objectives

The objectives of this study was to develop improved performance prediction models to be used for determining the additional life that can be expected from application of a variety of asphalt concrete (AC) rehabilitation models and strategies ranging from minimal to maximum investment in the rehabilitation treatment. The study objectives include a determination of the influence of environmental region and initial pavement condition on the effectiveness of rehabilitation methods. These objectives were planned to be accomplished through a statistically valid experiment incorporating the factors affecting rehabilitated asphalt concrete pavements.

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DESCRIPTION OF SPS-5 EXPERIMENT

Introduction

The primary factors to be studied in SPS-5 are: 1) the degree of surface preparation, 2) overlay material (recycled or virgin AC), 3) thickness of AC overlay, and 4) environmental (climatic) factors. Other considerations are: 1) existing condition of the pavement, 2) subgrade soil, and) traffic volume and load. In addition, ADOT decided to study the asphalt rubber asphalt concrete (AR-AC) and recycled overlay over virgin AC as part of the SPS-5 study.

Experimental Design

In order to study the factors outlined earlier, the experimental design shown in Table 1 was laid out. The plan identifies site related factors and their relationships with each other. Table 1 identifies site related factors across the top and rehabilitation treatments down the sides. Each column in this plan represents two project locations each of which incorporates several test sections. Each row represents a series of test sections with specific features to be constructed at each project location. Rehabilitation was designed to be done at two levels of surface preparation, two types of overlay material, and two overlay thicknesses. This will result in eight test section combinations at each of the sixteen projects selected for study. In addition, each of the project sections will include a control test section which will only receive routine maintenance (i.e., routine pothole filling, crack repair and sealing). In addition ADOT added two more test sections of asphalt rubber and recycled asphalt concrete in this study. Details of the experimental design and site selection guideline are presented in SHRP SPS-5 Experimental Design and Research Plan in Appendix A.

Test Section Layout and Features

Eight SHRP test sections and Two ADOT test sections were built as part of the ADOT construction project IR-8-2(91). The test sections were located on the travel lane in between MP. 159 (Station 2220+40) and 161 (Station 2328+64) in the East bound direction of Interstate 8. The

TABLE 2-SPS-5 TEST SECTION LOCATION AND FEATURES

SHRP ID	ADOT ID	Location From	Location To	Surface Preparation	Overlay Material	Overlay Thickness
040507	1	2224+91	2229+91	Intensive	Virgin	2-inch
040504	2	2232+55	2237+55	Minimum	Virgin	5-inch
040503	3	2240+35	2245+35	Minimum	Recycled	5-inch
040508	4	2254+00	2259+00	Minimum	Recycled	5-inch
040509	5	2263+13	2268+13	Intensive	Recycled	2-inch
040502	6	2277+31	2282+31	Minimum	Recycled	2-inch
040506	7	2285+40	2290+40	Intensive	Virgin	2-inch
040505	8	2291+43	2296+43	Minimum	Virgin	2-inch
040510*	9	2299+27	2304+27	Intensive	Recycled	2-inch
040511*	10	2308+66	2314+66	Minimum	AR-AC**	2.5 inch
040501	11	2316+45	2321+45	Routine Maintenance		Control

* ADOT experimental test sections

** Asphalt Rubber Asphalt Concrete

SHRP 040501 is the control section or part of the existing pavement left as it was condition. This section will receive only routine maintenance. Each section is referenced with respect to a brass cap located at Station 2253+00. No equation was recognized in section delineation. Each test section has SHRP test section sign along with the experimental feature at the beginning of the test section on the shoulder and also by the fence on the right-of-way. Also SHRP test section numbers were painted on the shoulder for each test section. Delimiters with blue reflectors were also used to delineate the test sections. Figure 1 shows the layout of the test sections.

EXISTING PROJECT DESCRIPTION

Location

The project is located in South-Western Arizona approximately 17 miles west of Casa Grande. The existing project extended from MP 147.60 to 160.87 on the East bound direction of Interstate-8. The project numbered I8-2(46) was built in 1968 and was flushed in 1970. The roadway was a divided highway with 2-lanes in each direction. The roadway width is 38 feet with 4 feet inner and 10 feet outer AC shoulder. The highway is located on a fill section. In this report, the existing project would mean the part of the existing pavement extending from M.P. 159 to M.P. 161.

Pavement Section

The pavement section consists of 8 inch Select Material (SM), 6 inch Aggregate Base (AB) and 4.5 inches of Asphalt Concrete. The surface course has an 1/2 inch open graded Asphalt Concrete Friction Course (ACFC) at the top. Figure 2 shows the structural section of the existing pavement. The structural number of the pavement was 3.32.

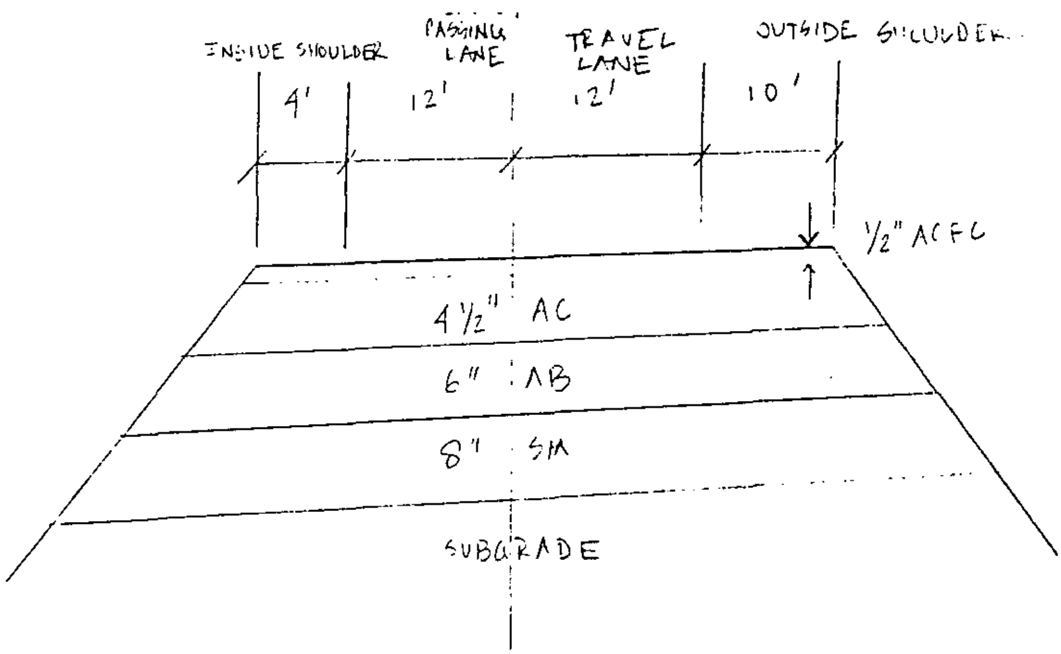


Figure 2- Structural Section of Existing Pavement

Soils & Geology

The geological formation of the area is weakly to moderately consolidated alluvium of early Quaternary to late Tertiary age. The vegetation is Sonoran desertscrub in lower Colorado subdivision. The soils in this area are mostly aridisoils with pedogenic horizons and low organic matter. These soils are mostly fine silts to poorly graded sand. Gravels are also present.

Climate

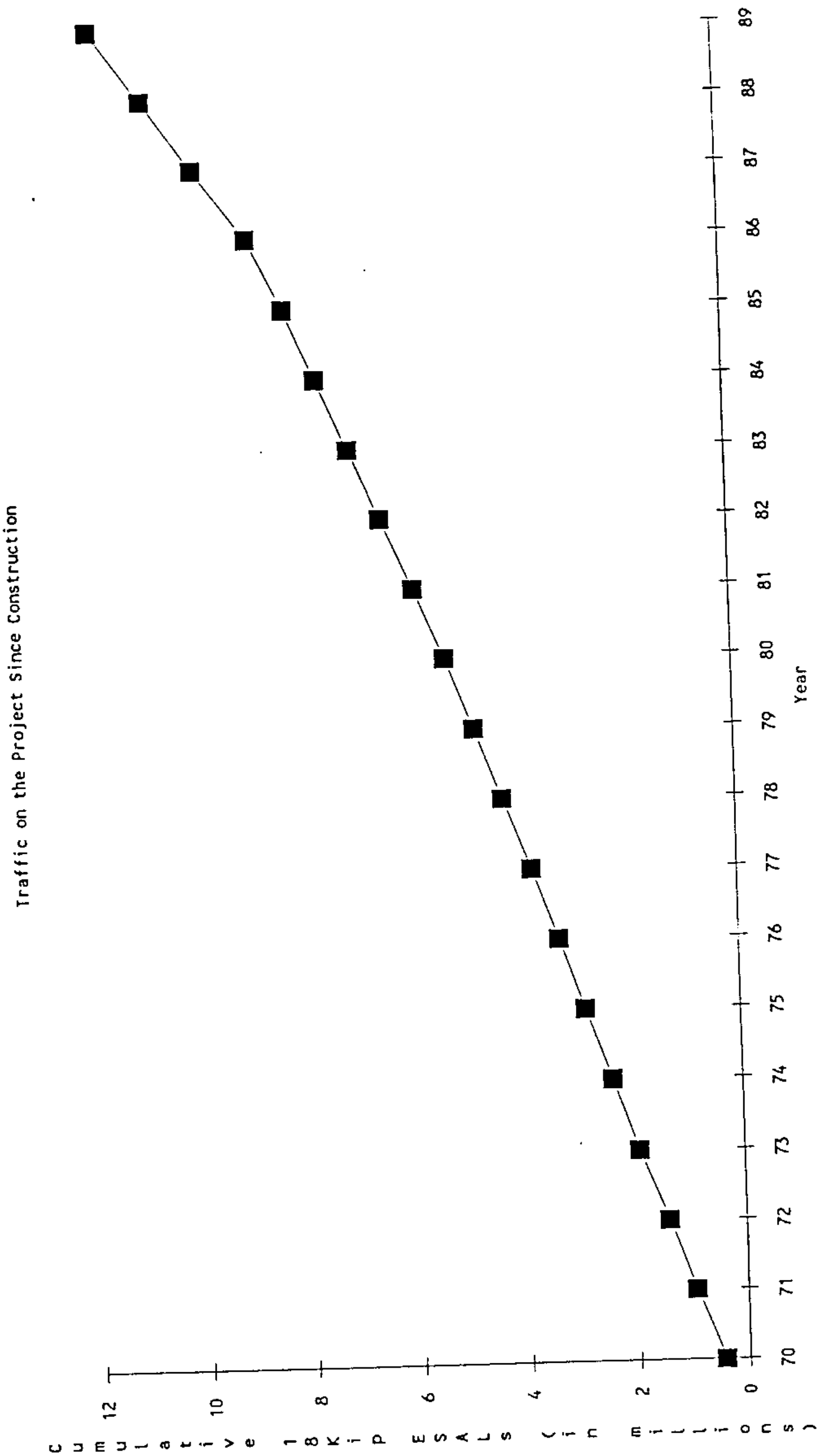
The climate in this region is very dry with extremely high temperatures in summer and little precipitation. The mean 30-year precipitation is 0.30 inch. Figure 3 shows the 30-year average annual high and low temperature for the months of March to September. The temperatures during and since construction of the SPS-5 test sections have been superimposed. As noted in the figure, weather during and since construction has been typical for the area. Figure 4 shows the average daily high and low temperatures during construction of SPS-5 test sections.

The referenced meteorological data were recorded at the National Weather Services Station at Casa Grande.

EXISTING PAVEMENT PERFORMANCE

Traffic History

The project currently incurs 7,814 ADT with 4.9% growth factor. The percent commercial vehicles on this project was 32% in 1989. The estimated 18-kip Equivalent Single Axle Loads (ESALs) was around 1 million in 1989. Figure 5 shows the growth of the traffic since construction.


Traffic on the Project Since Construction
Cumulative 18Kip ESALs (in millions)
0
2
4
6
8
10
12
Year
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89

FUNCTIONAL PERFORMANCE

Testing Performed and Purpose

The functional performance of the roadway can best be described by its serviceability. In this report the present serviceability is described in terms of roughness, measured by the Mays Ride Meter, and frictional characteristics assessed using the Mu-Meter.

Arizona performs an annual inventory of its highway network and records this information on a route-milepost basis. Roughness, skid, patching, and faulting are measured in the travel lane and entered into the pavement management system database.

Roughness is determined by a Mays Ride Meter (car) traveling at 50 MPH which obtains continuous readings between mileposts. The readings are summarized in inches per mile and the results assigned to the milepost location at which the readings begin. Once the field data is obtained it is normalized to 1972 calibration values to provide consistency with time.

Skid (friction) is determined by a Mu-Meter which is a continuous recording friction measuring trailer. Continuous readings are obtained for a five hundred foot section of wet pavement starting at a milepost location. The readings are averaged and assigned to the milepost.

Roughness Data

Roughness data as a function of time since original construction are shown in Figure 6 for each milepost location. These data indicate that the two milepost locations have performed almost similarly, increasing in roughness approximately 9 to 12 inches per year. Linear regressions were performed on these data to establish the trend of roughness increase. The results of these analyses are shown in Table 3. The estimated roughness at original construction has been taken as the value of the 1972 data since it was the first year that Mays Meter measurements were available. It is to be noted since the Maysmeter data is collected from milepost to milepost in the direction of travel and assigned to the beginning of the milepost, roughness data collected at mileposts 159 and 160 for this project are slightly tainted.

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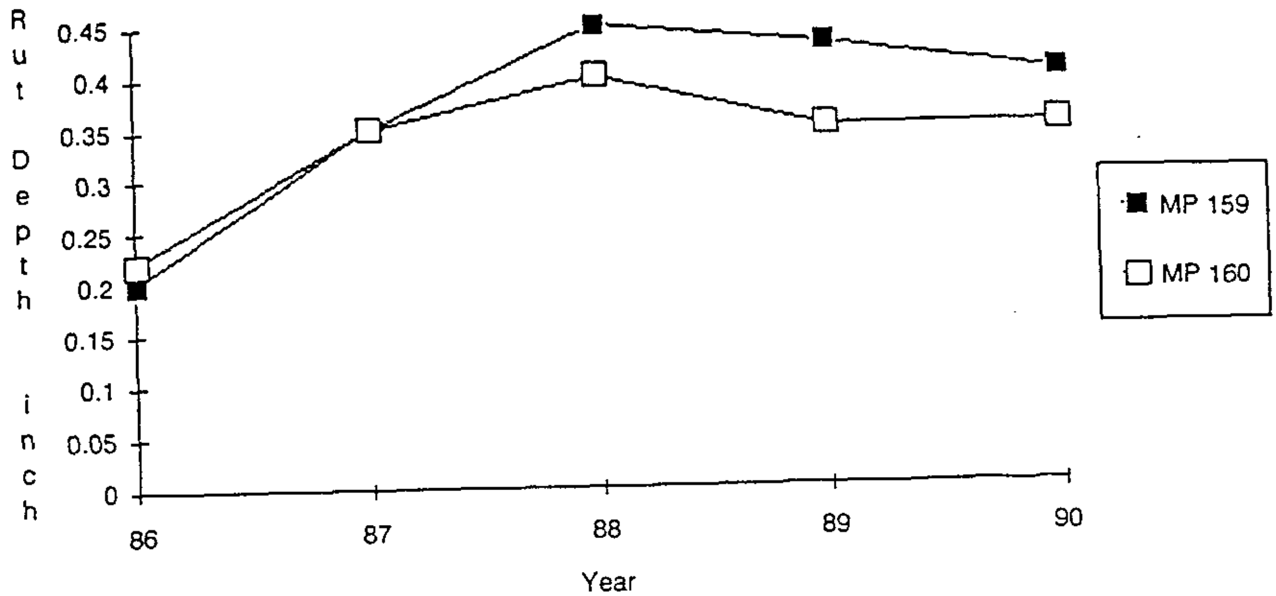

Figure 8- Rut Depth Vs. Time

TABLE 5- REGRESSION RESULTS FOR STRUCTURAL PERFORMANCE PARAMETERS

Parameter	Initial Value	Value at Rehab.	Rate of Increase/Decrease	R2
Rut Depth (in)	0.22 (1986)	0.35	0.026	0.04
Cracking (%)	0.00 (1980)	20.0	1.900	0.37
Patching (%)	0.00 (1986)	00.0	--	--

A linear regression of traffic loading (expressed in millions of 18Kip ESALs) and rutting (expressed in inch) resulted in the following equations:

MP 159:	Rut Depth = -0.407 + 0.074 * ESALs	$R^2 = 0.70$
MP 160:	Rut Depth = -0.150 + 0.046 * ESALs	$R^2 = 0.55$

Although the correlations are fair, the slopes suggest that the rut depth was increasing rapidly with traffic loading.

Cracking Data

Figure 9 indicates the percent of cracking as a function of time for the milepost 160. No cracking is evident prior to 1981 because this data was not included in the PMS data base prior to this. It should be noted that at the time of construction (1990), cracking was 20%. At about 1988, this mile post location showed a significant increase in crack development.

Table 5 shows the linear regression of the crack data prior to the rehabilitate project. The cracking has increased on an average of 2 percent per year since 1980. It should be noted that the pavement design summary indicated that the project exhibited approximately 5% cracking on both travel lane and passing lane from MP 157.0 and 160.0 and 30% alligator cracking in travel lane from Mileposts 160.0 to 160.87. The reason for the large disparity on the level of cracking reported in ADOT's PMS database and that reported in the design summary is not known. However, it should be noted that in ADOT pavement management system data collection process, crack survey on only 1000 square feet at the beginning of the milepost location is reported as the percent cracking for the entire mile of the pavement. The validity of these data to represent project cracking is questionable.

As shown in Table 5, no patching existed on this project prior to the rehabilitation.

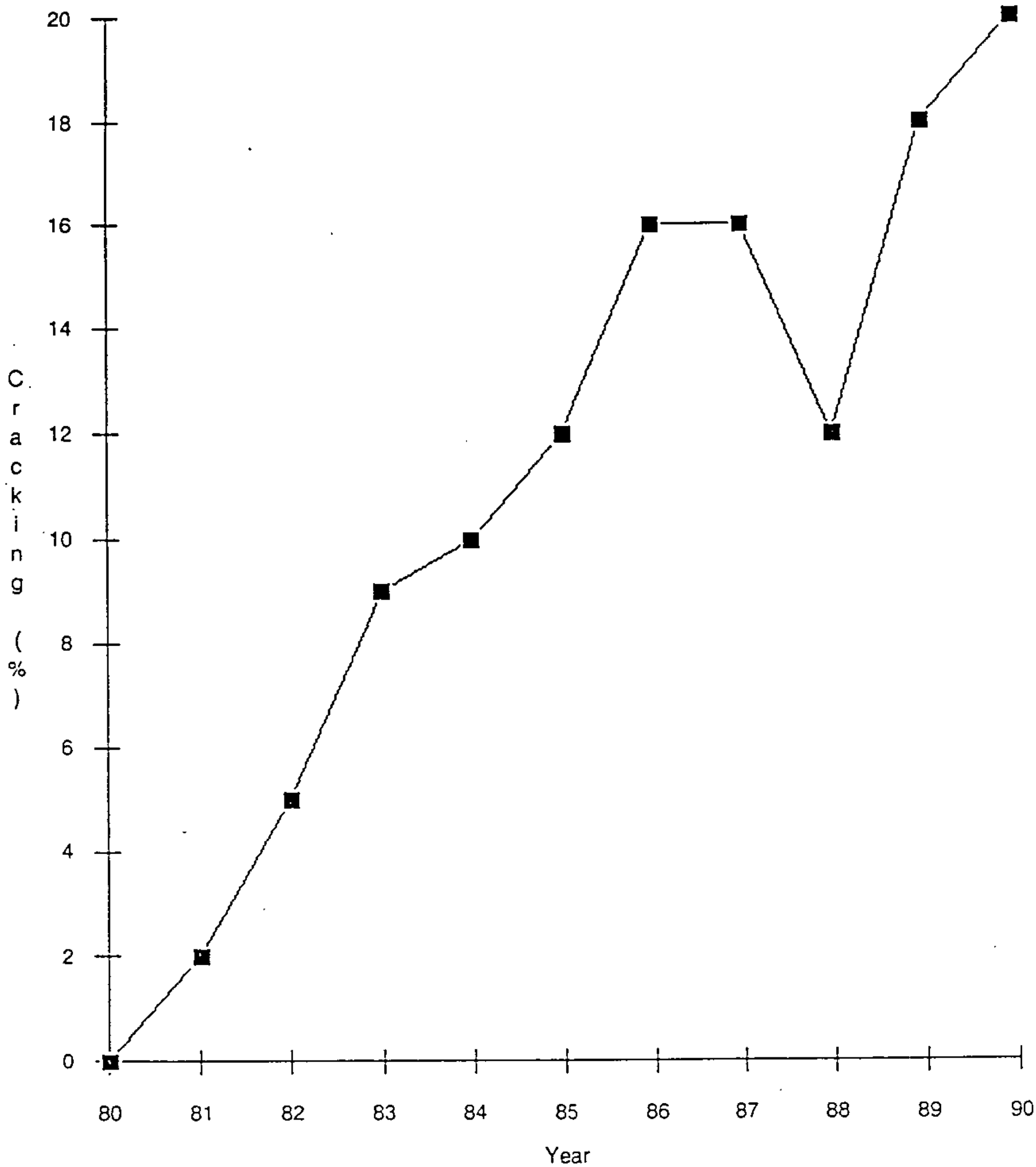

Figure 9- Cracking (%) vs. Time

Material Related Problems

Since ADOT's PMS does not report any material related distress like stripping, no records are available on the development of this distress. However, pre-construction inspection of this project did not reveal any stripping problem on this project.

Deflection Testing

Dynaflect deflection testing was performed in March, 1985 to evaluate the structural capacity of the existing pavement. The peak to peak test load was approximately 1000 pounds at a frequency of 8 MHz. A total of 8 deflection tests were conducted between MP 160.0 and MP 161.0 at one third of a mile interval. Tests were conducted on both travel lane and passing lane. A summary of the dynaflect results are shown in Table 6. The average center deflection values indicate that both lanes were performing similarly as far as structural characteristics were concerned. The low coefficient of variation of the fifth sensor deflections for both lanes indicate that the subgrade response was uniform over the entire project. The average coefficients of variation for deflections were 10% and 12% for the travel and passing lanes, respectively.

TABLE 6 - DYNAFLECT DEFLECTION TEST RESULTS

	Travel Lane					Passing Lane				
Statistic	1*	2*	3*	4*	5*	1*	2*	3*	4*	5*
$\bar{X}$	.90	.60	.32	.19	.12	.84	.60	.35	.19	.11
Std. Dev	.0.4	.04	.03	.02	.02	.16	.07	.02	.01	.02
C.V.	5%	7%	9%	11%	17%	19%	12%	6%	5%	19%
Range	.85-.94	.55-.65	.29-.36	.16-.20	.10-.15	.62-.98	.5-.65	.32-.37	.17-.19	.08-.12

* Sensor number.

Note: All deflection readings are in mils

Falling Weight Deflectometer (FWD) testing was done in January of 1989 to assess the structural characteristics of the project during the design phase. Layer moduli were backcalculated from the FWD data using BKCHEVM (3) backcalculation program. Table 7 shows the summary of the backcalculation analysis. From the table, it is evident that the variation of the subgrade moduli is minimum indicating a uniform subgrade response for the project. The variation of other layer moduli ranged from 53% for the AC layer and 78% for the subbase (Select Material) layer. The average modulus for the AC layer is 210 ksi which indicates a deteriorated or weakened asphalt concrete surface layer. The high moduli of the base and subbase layer indicate a very

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sound base supporting this project. This probably explains the unusually good performance of this project as far service life of the project is concerned.

TABLE 7 - BACKCALCULATED LAYER MODULI FWD DEFLECTION DATA

Backcalculated Layer Moduli (ksi)				
	E_1^*(AC)	E_2(AB)	E_3(SM)	E_4(Subgrade)
159.33	288	17	64	36
159.66	77	116	63	33
160.00	189	46	10	34
160.33	140	89	23	28
160.66	355	17	24	26
Avg	210	57	37	31
Std. Dev.	112	44	25	4
C.V.(%)	53	77	68	13

* Unadjusted Modulus

MAINTENANCE COSTS

Description of Activities

Significant maintenance activities were performed on this project just prior to the rehabilitation project.

Figure 10 represents the reported maintenance costs at the mileposts associated with the test sections for the period 1979-1989. As noted, very high maintenance costs are evident during 1989 just before the rehabilitation.

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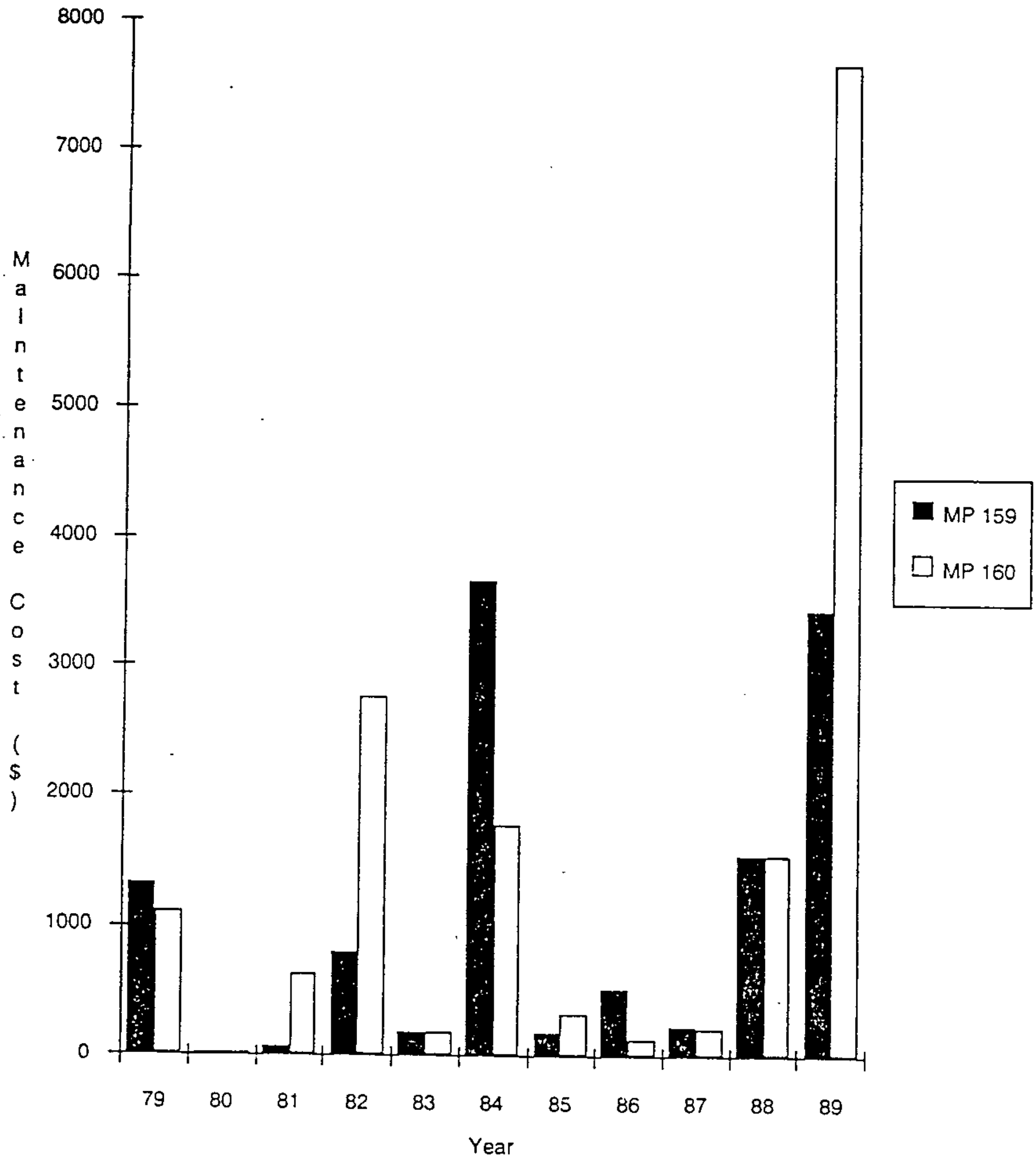


Figure 10- Roadway Maintenance Cost ($) for the Existing Project for the Years 1979-1989

CONSTRUCTION PROJECT DESCRIPTION

Section Designs and Specifications

All the SHRP test sections were designed following the ideas in the SHRP "Specific Pavement Studies Experimental Design and Research Plan for Experiment SPS-5 Rehabilitation of Asphalt Concrete Pavements" as of April, 1989. A copy is included in Appendix A. The designs were included in ADOT construction project IR-8-2(91). Figure 11 shows the construction sections and Figure 12 shows the pavement sections for each test section. A brief description of design features is as follows:

Test Section 1 (SHRP 040507): Mill 2 1/2 inches of existing pavement and replace with 2" virgin AC (3/4") (End Product). A tack coat is to be placed on the milled surface before replacing with 2" AC. A 5-inch overlay is to be constructed in 2 lifts of 2" virgin AC (3/4") (End Product) and 3" virgin AC (3/4") (End Product). A tack coat is to be placed before and after the first lift. The total nominal thickness was 7 inches.

Test Section 2 (SHRP 040504): Mill 1/2 inch of existing pavement and replace with 2" virgin AC (3/4") (End Product). A tack coat is to be placed on the milled surface before replacing with 2" AC. A 3-inch overlay is to be constructed with a single lift of 3" virgin AC (3/4") (End Product). A tack coat is to be placed before placing the overlay. The total nominal thickness was 5 inches.

Test Section 3 (SHRP 040503): Mill 1/2 inch of existing pavement and replace with 2" Recycled AC. A tack coat is to be placed on the milled surface before replacing with 2" AC. A 3-inch overlay is to be constructed with a single lift of 3" Recycled AC. A tack coat is to be placed before placing the overlay. The total nominal thickness was 5 inches.

Test Section 4 (SHRP 040508): Mill 2 1/2 inches of existing pavement and replace with 2" Recycled AC. A tack coat is to be placed on the milled surface before replacing with 2" AC. A 5-inch overlay is to be constructed in 2 lifts of 2" Recycled AC and 3" Recycled AC. A tack coat is to be placed before and after the first lift. The total nominal thickness was 7 inches.

Test Section 5 (SHRP 040509): Mill 2 1/2 inches of existing pavement and replace with 2" Recycled AC. A tack coat is to be placed on the milled surface before replacing with 2" AC.

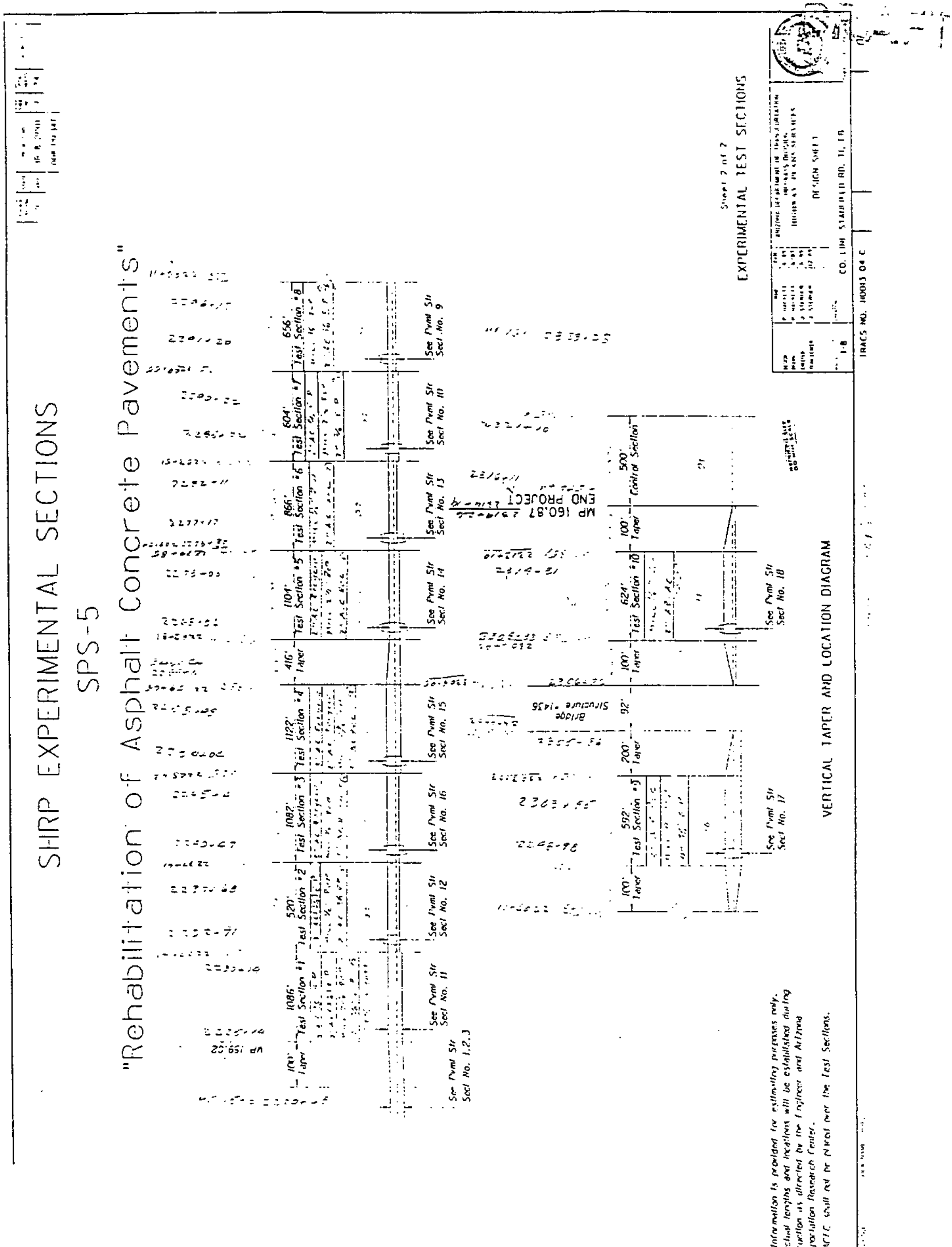
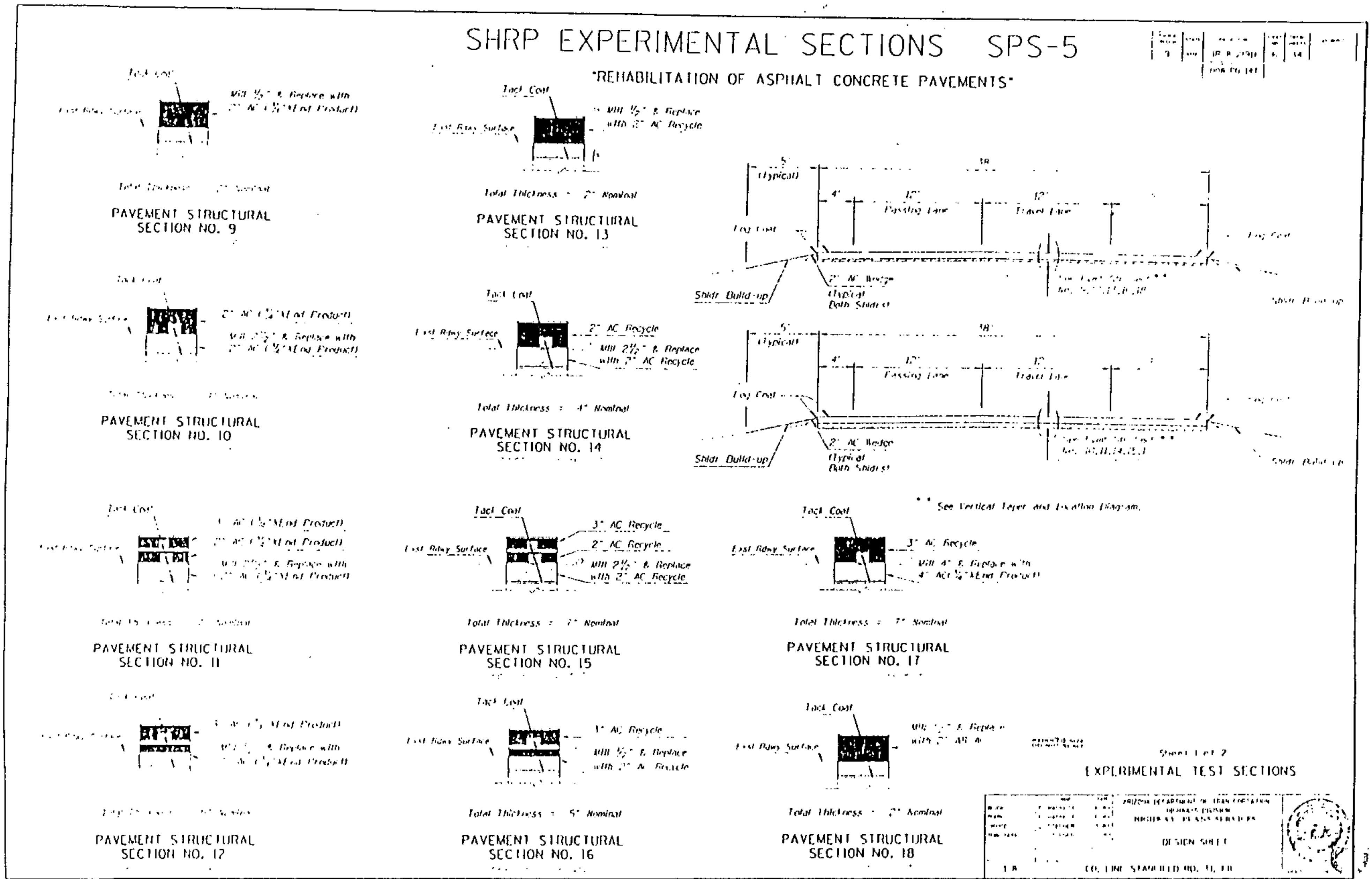


Figure 11- Construction Plan of SPS-5 Test Sections


SHRP EXPERIMENTAL SECTIONS SPS-5
"REHABILITATION OF ASPHALT CONCRETE PAVEMENTS"
PAVEMENT STRUCTURAL SECTION NO. 9
PAVEMENT STRUCTURAL SECTION NO. 10
PAVEMENT STRUCTURAL SECTION NO. 11
PAVEMENT STRUCTURAL SECTION NO. 12
Tack Coat
Exst Rdwy Surface
Mill ½" & Replace with 2" AC Recycle
Total Thickness = 2" Nominal
PAVEMENT STRUCTURAL SECTION NO. 13
Tack Coat
Exst Rdwy Surface
2" AC Recycle
Mill 2½" & Replace with 2" AC Recycle
Total Thickness = 4" Nominal
PAVEMENT STRUCTURAL SECTION NO. 14
Tack Coat
Exst Rdwy Surface
3" AC Recycle
2" AC Recycle
Mill 2½" & Replace with 2" AC Recycle
Total Thickness = 7" Nominal
PAVEMENT STRUCTURAL SECTION NO. 15
Tack Coat
Exst Rdwy Surface
1" AC Recycle
Mill ½" & Replace with 2" AC Recycle
Total Thickness = 5" Nominal
PAVEMENT STRUCTURAL SECTION NO. 16
Tack Coat
Exst Rdwy Surface
3" AC Recycle
Total Thickness = 7" Nominal
PAVEMENT STRUCTURAL SECTION NO. 17
Tack Coat
Exst Rdwy Surface
Total Thickness = 2" Nominal
PAVEMENT STRUCTURAL SECTION NO. 18
5' (Typical)
38'
4'
12' Passing Lane
12' Travel Lane
Fog Coat
Shldr Build-up
2" AC Wedge (Typical Both Shldrs)
* * See Vertical Taper and Location Diagram.
Sheet 1 of 2
EXPERIMENTAL TEST SECTIONS
DESIGN SHEET
TRACS NO.

A 2-inch overlay is to be constructed with a single lift of 2" Recycled AC. A tack coat is to be placed before placing the overlay. The total nominal thickness was 4 inches.

Test Section 6 (SHRP 040502): Mill 1/2 inch of existing pavement and replace with 2" Recycled AC. A tack coat is to be placed on the milled surface before replacing with 2" AC. The total nominal thickness was 2 inches.

Test Section 7 (SHRP 040506): Mill 2 1/2 inches of existing pavement and replace with 2" AC (3/4") (End Product). A tack coat is to be placed on the milled surface before replacing with 2" AC. A 2-inch overlay is to be constructed with a single lift of 2" AC (3/4") (End Product). A tack coat is to be placed before placing the overlay. The total nominal thickness was 4 inches.

Test Section 8 (SHRP 040505): Mill 1/2 inch of existing pavement and replace with 2" AC (3/4") (End Product). A tack coat is to be placed on the milled surface before replacing with 2" AC. The total nominal thickness was 2 inches.

Test Section 9 (SHRP 040510; ADOT): Mill 4 inches of existing pavement and replace with 4" AC (3/4") (End Product). A tack coat is to be placed on the milled surface before replacing with 2" AC. A 3-inch overlay is to be constructed with a single lift of 3" Recycled AC. A tack coat is to be placed before placing the overlay. The total nominal thickness was 7 inches. It is important to note that this section is a kind of inverted section where recycled overlay was placed on virgin material binder course.

Test Section 10 (SHRP 040511; ADOT): Mill 1/2 inch of existing pavement and replace with 2" Asphalt Rubber Asphalt Concrete (AR-AC). A tack coat is to be placed on the milled surface before replacing with 2" AC. The total nominal thickness was 2 inches.

Test Section 11 (SHRP 040501): This is the control section and is a part of the existing pavement. No treatment was applied on this section. Future treatments should include only routine maintenance.

The mix design, materials and construction details were specified by ADOT Standard Specifications for Road and Bridge Construction (4), Special Provisions for the project IR-8-2(91) and an addendum to the special provisions as of January 23, 1990. The Special Provisions and the

However, if the conditions permit, the treatment was suggested to be delayed for at least a year from the beginning of the project.

Asphalt Concrete Mix Design

The design of asphalt concrete mixes was specified to be done in compliance with the guidelines contained in the FHWA Technical Advisory T5040.27. The quality of aggregates were expected to be highest quality and additional specifications were presented. The asphalt cement grade and characteristics were left to the agency's discretion, so is the asphalt additive. Additional guidelines were also presented for recycled materials.

Construction Operations

Construction guidelines were specified to be those in compliance with the guidelines presented in the FHWA Technical Advisory in conjunction with the high quality construction practice of the agency. Additional construction related guidelines were also outlined.

Deviation from Guidelines

No deviation from the guidelines was allowed. All out-of-specification test sections were suggested to be removed, so are the materials, mixtures, surface preparations, and construction operations. But, potential impact of non-conformance on the overall experiment was suggested to be assessed through meeting of the agency representatives with their local SHRP representatives in the event that the SHRP guidelines could not be met.

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SAMPLING OF EXISTING PAVEMENT

Coring and drilling were done on the existing pavement of the proposed SHRP SPS-5 test sections to retrieve samples of existing materials and to characterize them through laboratory testing. The sampling and testing plan were documented in SHRP memorandum about Field Sampling and Laboratory Testing for SPS-5 as of January, 1990. The plans were revised later and a copy of the final plan appears in Appendix E.

Since the material sampling methods were destructive, they were planned close to, but outside the proposed test sections. The planned in-place material sampling and testing consisted of a combination of the following:

o 4-inch outside diameter cores of asphaltic concrete surface and binder courses only. C-type cores.

o 4-inch outside diameter cores of asphaltic concrete surface and binder courses, bound base layers, and treated subbase layers. C-type cores.

o 6-inch outside diameter cores of asphaltic concrete surface and binder courses, bound base layers, and treated subbase layers; Augering of unstabilized base and subbase layers; Split spoon sampling and/or Shelby tube sampling of subgrade layers to 5 feet below top of untreated subgrade. A-type cores/samples.

o 12-inch outside diameter cores of asphaltic concrete surface and binder courses, bound base layers, and treated subbase layers; Augering of unstabilized base, subbase layers and subgrade to 12 inches below top of untreated subgrade for bulk sample retrieval. BA-type cores/samples.

o 6-foot by 4-foot test pits to a depth of 12 inches below top of untreated subgrade for collection of pavement slabs; nuclear density and moisture measurements on unstabilized pavement layers and subgrade material; bulk sampling of unstabilized layers and subgrade. Test pit (TP) samples.

The planned laboratory tests on these retrieved samples were to evaluate physical and mechanical properties included a wide variety of tests on asphalt concrete, extracted aggregate, asphalt cement, bound (treated) base and subbase materials, unbound granular base and subbase materials, and subgrade materials.

The coring and drilling on SPS-5 test sections in Arizona were done by Chen-Northern, Inc. in January of 1990. The plans followed in sampling has been shown in the Appendix E. The sample areas correspond to SHRP test sections as shown in Table 8.

TABLE 8- CORRESPONDENCE BETWEEN SAMPLE AREA AND SPS-5 TEST SECTIONS

Sample Area	SHRP ID	STATE ID
S1	040507	1
S2	040504	2
S3	040503	3
S4	040508	4
S5	040509	5
S6	040502	6
S7	040506	7
S8	040505	8
S9	040510	9
S10	040511	10
S11	040501	11

Coring was done by a trailer rig and a CME-55 whereas, the test pits were dug by a back hoe. In-situ nuclear density and moisture content tests were done on the top of the base course and subgrade in the test pits. One 18 inches by 12 inches asphalt concrete block was retrieved from each test pit. In addition, few shoulder probes were also done. In total, Twenty-eight 4-inch dia cores, Ten 6-inch dia cores, Eleven 12-inch dia cores, 32 bag granular base samples, 7 bag granular subbase samples, and 30 bag subgrade samples were collected. A summary of inventory of samples collected is shown in Table 9.

The samples were retained by the ATRC personnel and were shipped to Western Technologies, Inc. in Phoenix for testing according to SHRP SPS-5 Material Testing Plan (Pre-construction).

The results of in-situ Nuclear density and moisture content tests done on the top of the base course and subgrade are shown in Table 10. The results are mean of four readings at each location. The depths of base course measurements were 4 and 6 inches for test pits 1 and 2 respectively, whereas, the depth of subgrade measurement was 8 inches for both test pits.

TABLE 10- IN-SITU NUCLEAR DENSITY AND MOISTURE CONTENT TEST RESULTS

Test Pit No.	Test Location	Density (pcf) Wet	Density (pcf) Dry	Moisture Content (%)
1	Base Top	128.9	123.7	4.1
	Subgrade Top	141.9	129.9	9.1
2	Base Top	130.7	125,5	4.1
	Subgrade Top	133.2	122.8	8.4

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TABLE 9- SUMMARY OF INVENTORY OF SAMPLES RETRIEVED

Sampling Area	Sample Type	No.	Depth/Size (in)
S1, S2, S2, S3, S4, S5	4" Dia Cores	15	81 1/2
	6" Dia Cores	4	23
	12" Dia Cores	2	18 1/2
	Granular Base Course Samples	10 bags, 5 jars	- -
	Granular Subbase Course Samples	4 bags, 5 jars	- -
	Subgrade Samples	10 bags, 5 jars	-
	Others:		
	Splitspoon	8	-
	Shoulder Probe	2	240
	Asphalt Concrete Block	1	18 X 12
S6, S7, S8, S9, S10, S11 S12	4" Dia Cores	13	68 1/2
	6" Dia Cores	6	40 3/4
	12" Dia Cores	9	53
	Pieces of Cores	8 bags	-
	Granular Base Course Samples	22 bags, 11 jars	- -
	Granular Subbase Course Samples	3 bags, 2 jars	- -
	Subgrade Samples	20 bags, 10 jars	-
	Others:		
	Splitspoon	16	-
	Shoulder Probe	2	240
	Asphalt Concrete Block	1	18 X 12

CHARACTERISTICS OF MATERIALS

Virgin Asphalt Concrete Mix (End Product) Design

The mix design was a 3/4-inch asphalt concrete mix design performed by Speedie and Associates, Phoenix, Arizona. The samples of aggregate used in the design were obtained from the Teepee Ready Mix pit in Casa Grande, Arizona. The materials were designated as a M.A. Coarse aggregate, a M.A. Intermediate aggregate, a washed fine aggregate, and a crushed fine aggregate. The asphalt cement used was grade AC-40 supplied by CHEVRON Asphalt Company and produced at their Richmond, California refinery. The mineral admixture used was Type II Portland Cement supplied by Arizona Portland Cement company. It was added to the mix at a rate of 2.0 % by weight of the mineral aggregate. The material characteristics conform to those required in ADOT Standard Specifications for Road and Bridge Construction, edition of 1987 (4) and the special provisions of the project. Tables 11 and 12 show the properties of asphalt cement and aggregate respectively.

A copy of the mix design is included in Appendix F. The recommended bitumen content was found to be 4.7%. Table 13 shows the comparison between the required criteria of mix design and those obtained by design.

TABLE 11- ASPHALT CEMENT PROPERTIES (AC-40)

Material	Test Result			Specs
	Mean	Std. Dev.	C.V.	
Asphalt Cement:				
Specific Gravity:	1.026	-	-	None
Absolute Viscosity (140^{O}F, poises)	3,934	41	1	3,200 - 4,800
Kinematic Viscosity (275^{O}F, cst, min)	400	-	-	300
Penetration (77^{O}F, 100 gms, 5 secs, mini)	28	3.6	1.3	20
Flash Point (P-M closed tester,^{O}F, min)		-	-	450
Solubility in TCE (%, min)	99.98	-	-	99
AC Residue:				
Absolute Viscosity (140^{O}F, poises, max)	7,711	360	4.7	16,000
Ductility (77^{O}F, cm, min)	150	-	-	45

TABLE 12- AGGREGATE PROPERTIES

Property	Coarse	Fine	Combined	Specification
Bulk OD Sp Gr	2.573	2.569	2.571	2.35 - 2.85
SSD Sp Gr	2.602	2.599	2.600	
Apparent Sp Gr	2.649	2.648	2.649	
Absorption	1.106	1.174	1.145	0.00 - 2.50
Sand Equivalent			67	45 minimum
Plasticity Index			NP	
Crushed Faces			63	30 minimum
L.A. Abrasion "B":				
100 Rev. % Loss			4	9 maximum
500 Rev. % Loss			17	40 maximum

TABLE 13- MIX DESIGN CRITERIA (3/4" MIX)

Criteria	Required as per Specs	Achieved by Design
Voids in Mineral Aggregate (VMA, %)	15.5 - 18.5	15.5
Air Voids (%)	5.8 - 6.2*	6.1
Index of Retained Strength (%, min)	50*	74.3
Wet Strength (psi, min)	150	462.6
Stability (lbs, min)	2000	3009
Flow (1/100 in)	8 - 16	12

* as per Special Provisions

Recycled Asphalt Concrete Mix Design

The mix design was done by the ADOT Central Materials Laboratory. The samples of aggregate used in the design were obtained from the Teepee Ready Mix pit in Casa Grande, Arizona. The materials were designated as a M.A. Coarse aggregate, a M.A. Intermediate aggregate, a washed fine aggregate, and a crushed fine aggregate. Also, 30% of aggregate were salvaged pavement. The asphalt cement used was grade AC-20 supplied by CHEVRON Asphalt Company and produced at their El Paso, Texas refinery. The mineral admixture used was Type II Portland Cement supplied by Arizona Portland Cement company. It was added to the mix at a rate of 1.0 % by weight of the mineral aggregate. The material characteristics conform to those required in ADOT Standard Specifications for Road and Bridge Construction, edition of 1987 (4) and the special provisions of the project. Tables 14 and 15 show the properties of asphalt cement and aggregate respectively.

TABLE 14- ASPHALT CEMENT PROPERTIES (AC-20)

Material	Test Result Mean	Std. Dev.	C.V.	Specs
Asphalt Cement:				
Specific Gravity:	0.996	-	-	None
Absolute Viscosity (140°F, poises)	1841	68	3.7	1000 - 2400
Kinematic Viscosity (275°F, cst, min)	345	-	-	210
Penetration (77°F, 100 gms, 5 secs, mini)	72	3.3	4.6	40
Flash Point (P-M closed tester, °F, min)	500	-	-	450
Solubility in TCE (%, min)	99.85	-	-	99
AC Residue:				
Absolute Viscosity (140°F, poises, max)	4150	169	4.1	12000
Ductility (77oF, cm, min)	87	-	-	60

TABLE 15- AGGREGATE PROPERTIES

Property	Coarse	Inter	W-sand	Fine	Salvaged	Combined
% Use	29	7	30	4	30	-
Sand Equivalent						71
Crushed Faces						79
L.A. Abrasion:						
100 Rev. % Loss						49
500 Rev. % Loss						20

A copy of the mix design is included in Appendix F. The recommended bitumen content was found to be 3.5%. Table 16 shows the comparison between the required criteria of mix design and those obtained by design. The design also required that the mineral aggregate be mixed with the required cement in the presence of 3 to 5% moisture by weight of the aggregate.

TABLE 16- MIX DESIGN CRITERIA (RECYCLED CONCRETE)

Criteria	Required as per Specs	Achieved by Design
Air Voids (%)	5.0 - 7.0	5.4
Index of Retained Strength (%, min)	50*	90.8
Wet Strength (psi, min)	150	366
Stability (lbs, min)	2000	3469
Flow (1/100 in)	8 - 16	10

* as per Special Provisions

Asphalt Rubber Asphalt Concrete (AR-AC) Mix Design

The mix design for asphalt rubber asphalt concrete was done by the ADOT Central Materials Laboratory. The samples of aggregate used in the design were obtained from the Teepee Ready Mix pit in Casa Grande, Arizona. The materials were designated as a Coarse aggregate, a Intermediate aggregate and a washed fine aggregate. Twenty percent granulated rubber of Type C106 was used in rubberized asphalt supplied by International Rubber, Inc. of Chandler, Arizona. The asphalt rubber was used at a rate of 7 percent in the mix. The asphalt cement used was grade AC-10 supplied by SUNBELT refinery company and produced at their Coolidge, Arizona plant. The mineral admixture used was Type II Portland Cement supplied by Arizona Portland Cement company. It was added to the mix at a rate of 2.0% by weight of the mineral aggregate. The specifications for materials characteristics conform to those required in ADOT Standard Specifications for Road and Bridge Construction, edition of 1987 (4), the special provisions and addendum to special provisions of the project. Tables 17, 18 and 19 show the properties of rubberized asphalt, AC-10 asphalt cement and aggregate respectively. The asphalt rubber material was reacted for 24 hours by International Surfacing Inc. It is important to note that two other mix designs were tried-one of them without any mineral admixture. One design was discarded due to low stability value, and the other one without mineral admixture could not satisfy the index of retained strength criteria.

A copy of the mix design is included in Appendix F. The design asphalt rubber content was found to be 7.0%. Table 20 shows the properties of the mix achieved by the design. The design required that a minimum of 20% granulated rubber be added, by weight, to the asphalt cement.

TABLE 17- RUBBERIZED ASPHALT PROPERTIES*

Test Parameter	Test Result	Specifications
Haake Viscosity ($350^{o}F$, cps)	5500	1500 - 4000
Brookfield Viscosity ($350^{o}F$, cps)	5750	-
Penetration, 1/10 mm (77oF, 100 gms, 5 secs, min)	55	20 min
Softening Point, ^{o}F	144	450
Resilience (%)	32	15 min.

* determined after construction

TABLE 18- ASPHALT CEMENT (AC -10) PROPERTIES

Material	Test Result	[illegible]
Asphalt Cement:		
Specific Gravity:	1.014	
Absolute Viscosity (140°F, poises)	952	[illegible]
Kinematic Viscosity (275°F, cst, min)	195	[illegible]
Penetration (77°F, 100 gms, 5 secs, min)	90	[illegible]
Flash Point (P-M closed tester, $^{\circ}$F, min)	425	[illegible]
Solubility in TCE (%, min)	99.9	[illegible]
AC Residue from RTFO:		
Viscosity (140°F, poises, max)	1993	[illegible]
Ductility (77oF, cm, min)	100+	[illegible]

* as per addendum to Special Provisions

TABLE 19- AGGREGATE PROPERTIES

Property	Coarse	Fine	Combined	Specification*
Bulk OD Sp Gr	2.545	2.593	2.562	2.35 - 2.85
SSD Sp. Gr.	2.581	2,618	-	-
Water Absorption (%)	1.41	0.95	1.25	0.00 - 2.50
Sand Equivalent			60	55 minimum
Crushed Faces (%)			80	70 minimum
L.A. Abrasion:				
100 Rev. % Loss			4	9 maximum
500 Rev. % Loss			19	40 maximum

* as per addendum to Special Provisions

TABLE 20- MIX PROPERTIES OF ASPHALT RUBBER ASPHALT CONCRETE

Property (with 7% rubber)	Achieved by Design
Air Voids (%)	3.5
V.M.A. (%)	18.2
Asphalt Absorption (%)	0.50
Bulk Density, pcf	141.0
Maximum Density, pcf	146.1
Stability (lbs, min)	1376
Flow (1/100 in)	11

HOT PLANT EQUIPMENT AND SETUP

Hot Plant

The hot plant was a Cedar Rapids drum plant with a maximum rated capacity of 600 tons per hour. Corn construction company typically operated the plant at an operating capacity of 400 tons per hour. The plant utilized a center feed for recycle introduction into the hot plant. The plant utilized "digi-blend" automated controls to control the feed rates of the aggregate, asphalt and recycled materials. The controls generate digital reports for the production in tons per hour across the belts and the total tonnage to date for asphalt, AC mix and recycled mix. The burner fuel used for the plant during the operation was number 2 diesel fuel.

Cold Feed Bins

Four cold feed bins were employed for the virgin aggregate. The bins, which were individually controlled at the hot plant discharged on to a common conveyor belt which then discharged on to an intermediate belt leading to the mechanical mixture used to mix the aggregate and cement admixture with water. Real time weighing of the aggregates on the belts was performed with Ramsey belt scales. The aggregate gradation of each bin is shown in Table 21.

Cement Silo and Pugmill

One percent cement was introduced into the recycled asphalt concrete to improve the retention properties. This was accomplished by mechanically mixing the cement with aggregate and water in a pugmill type mixer. A vertical cement silo discharged through a vane auger onto a weigh belt which distributed the cement into a vane feeder. The feeder, in turn, delivered the cement onto the common belt through a pipe outlet just ahead of the aggregate discharge point and just prior to the mixing water and pugmill mixer.

Storage Silo

A 100-ton storage silo was used as a gob hopper to load the haul vehicles. The hauling distance was an average of 13 miles.

An aerial photo of the hot plant set-up is shown in Photo 1.

TABLE 21- AGGREGATE GRADATION OF DIFFERENT COLD FEED BINS

Aggregate Type	Sieve Size	Percent Passing
Coarse	1 in.	100
	3/4 in.	75-100
	3/8 in.	23-43
	No. 200	0-2
Intermediate	1/2 in.	100
	3/8 in.	80-100
	1/4 in.	30-80
	No. 8	0-20
	No. 200	0-3
Crushed Fines	3/8 in.	100
	1/4 in.	90-100
	No. 8	55-85
	No. 40	10-38
	No. 200	5-11
Washed Sand	3/8 in.	100
	1/4 in.	90-100
	No. 8	65-85
	No. 40	11-31
	No. 200	0-4

Calibration of Hot Plant

Corn Construction Company was completing a project on Interstate-10 at the time of award of contract of this project. The plant was located approximately 0.25 mile north of Interstate-8 on the west side of Trekel Road in Casa Grande. The plant was not moved for this project. Asphalt Concrete Friction Course (ACFC) production for the I-10 project was completed on April 20, 1990. The plant was recalibrated in the night of April 20 to accommodate the production of recycled asphalt concrete which was scheduled to begin on April 23, 1990. Since the plant had been in continuous operation up to this time, the asphalt pump was not recalibrated. The cold feed bins and the recycle bins were calibrated by the contractor by comparing the belt totals to platform scale totals. The platform scales were located beneath the discharge of storage silo. ADOT personnel did not verify the scale weights. They only observed the calibration procedure.

CHANGE ORDERS ABOUT CONSTRUCTION

A change order was requested by the ATRC on April 20, 1990 to incorporate the following changes in construction of SHRP test sections. Some of these changes were eventually implemented during construction of test sections.

(1) The maximum overlay thickness should be 2.5 inches. This would require placing two 2.5 inch lifts in test sections 1, 2, 3, and 4 instead of the 2 inch and 3 inch lifts required earlier. Test section 9 was required to remain unchanged.

(2) The milling depth in all the SHRP test sections was reduced 1/2 inch. That eliminated the milling of ACFC on the test sections 2, 3, 6 and 8. The milling on test section 10 was required. The change altered the deep milling from 2.5 inches to 2 inches for test sections 1, 4, 5, and 7. Test section was required to have milled up to 4 inches.

(3) A 30-foot ski was required to be used for grade control when milling the SHRP test sections. Additionally, milling transitions between test sections were required to be tapered at a slope of 1/2 inch per 10 feet minimum. Plunge cuts were specified to be not acceptable.

CONSTRUCTION LAYOUT

The construction of SHRP and ADOT test sections for SPS-5 were carried out as per the plan for the project IR-8-2(91). Table 22 shows the layout of the test sections. The ADOT sections in the table correspond to the pavement designs and construction guidelines for the SHRP test sections. The SHRP sections are in between the ADOT sections and usually of 500 feet length except SHRP 040511 which is 600 feet. Construction of test sections was completed in 17 days. Table 23 shows the dates of construction. The table also shows the daily high and low temperatures on these days.

TABLE 22- CORRESPONDENCE BETWEEN SHRP TEST SECTIONS AND CONSTRUCTED TEST SECTIONS

Construction Section	Location From	Location To	SHRP Section	Location From	Location To
ADOT 1	2221+35	2231+55	040507	2224+91	2229+91
ADOT 2	2231+55	2237+87	040504	2232+55	2237+55
ADOT 3	2237+87	2252+00	040503	2240+35	2245+35
ADOT 4	2252+00	2261+00	040508	2254+00	2259+00
ADOT 5	2265+16	2275+23	040509	2268+13	2273+13
ADOT 6	2275+00	2283+00	040502	2277+31	2282+31
ADOT 7	2283+90	2290+95	040506	2285+40	2290+40
ADOT 8	2290+95	2297+40	040505	2291+43	2296+43
ADOT 9	2298+40	2304+48	040510	2299+27	2304+27
ADOT 10	2308+07	2314+90	040511	2308+66	2314+66

TABLE 23- DAYS OF SPS-5 CONSTRUCTION AND TEMPERATURE

Day	Date	Daily Temperature (^{O}F)	
		High	Low
1	April 25	82	62
2	April 26	77	55
3	May 1	77	53
4	May 2	78	54
5	May 3	86	54
6	May 4	92	62
7	May 8	97	63
8	May 16	93	59
9	May 17	98	62
10	May 18	95	64
11	May 21	95	53
12	May 22	98	64
13	May 23	103	69
14	May 24	100	76
15	May 31	93	61
16	June 4	111	67
17	June 13	102	69

CONSTRUCTION OF TEST SECTION 1 (ADOT 1 & SHRP 040507)

The ADOT 1 was milled and paved during days 8, 10, 11, 12, 13 of the 17-day work on SHRP test sections. The work consisted of milling existing two lanes of the test section and paving with end-product asphalt concrete in three lifts.

Milling Layout

The milling sequence is shown in Figure M1 and the milling depths are shown in Table M1. The pass sequence in Table M1 refers to milling sequence in Figure M1. Table 24 shows the range in mill depths for the two lanes and corresponding dates of milling.

TABLE M1- MEASURED DEPTHS OF MILLING IN ADOT'S TEST SECTION 1.

Transverse Location, Feet	Depth of Milling, Inches — Longitudinal Location Along SHRP Test Section, Feet						Average Milled Depth	Pass
	0	100	200	300	400	500		
4	1 3/4	2 1/4	2 1/4	2 3/4	2 1/2	2 3/8	2 3/8	8F
10	2 1/2	2 3/4	2 3/4	2 3/4	2 1/2	2 1/2	2 5/8	8E
16	3	2 5/8	2 3/4	2 3/4	2 3/4	2 1/2	2 6/8	8B
22	3	2 7/8	3	2 3/4	2 7/8	2 1/2	2 7/8	8B
26	3 1/8	3	2 3/4	2 3/4	3	2 5/8	2 7/8	10C
32	2 7/8	2 7/8	2 3/4	2 5/8	2 7/8	2 5/8	2 3/4	10B

Note: Transverse location is reported in feet, measured from right edge of the east bound roadway.

TABLE 24- RANGE IN MILLING DEPTHS FOR ADOT 1 ON DIFFERENT LANES

Lane	Date	Day	Range of Depth (in)
LEFT	5/18/90	10	2 5/8 - 3 1/8
RIGHT	5/16/90	8	2 1/2 - 3

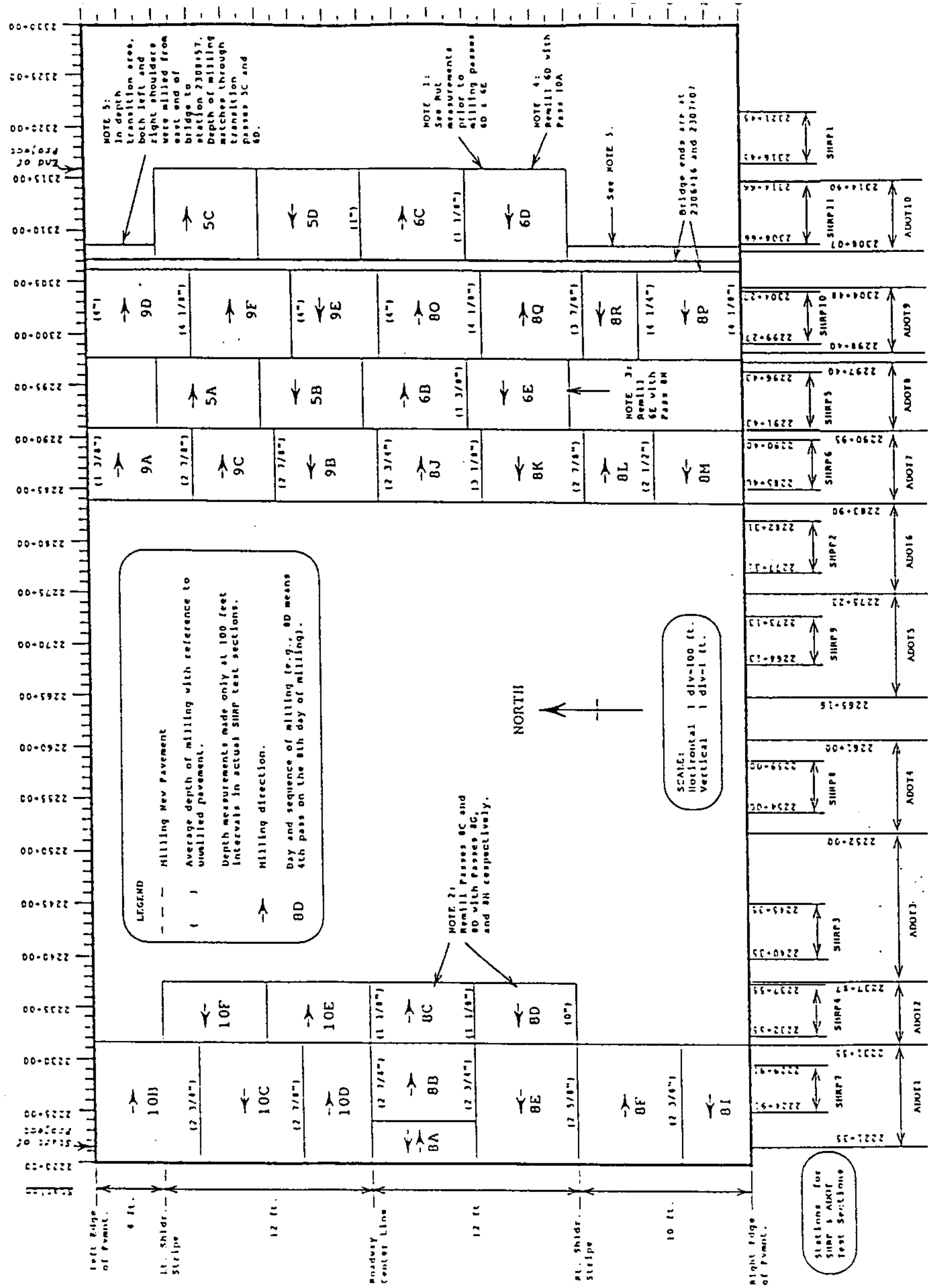

Figure M1- Pass Sequence of Milling on ADOT 1

Milling Process

The milling machine employed was a CAT PR-450 type. The same machine was used throughout the entire project. The left pass milling for the right lane trench in ADOT 1 for some reason began at the beginning of SHRP 040507 and progressed west to the beginning of ADOT 1. Contractor was instructed to make this pass again from beginning of ADOT 1 to the end of ADOT 1. The result was that the 2.75" depth for this ADOT 1 trench was not really tapered at the beginning of ADOT 1. Photos 2 through 7 show the miller and the milling process. Photos 8 through 13 show the surface texture of milled surface and mill depth measurement process.

The milled surface was cleaned with a dry reel broom. In all sections, the freshly milled surfaces were broomed with a dry reel broom. The reel was angled to push loose material toward the shoulder. This broom set right on vertical edges created by milling and was effective in keeping loose material out of the corners. After a few passes of this broom a pickup broom was used. At the beginning of the job this broom collected loose material and lifted it and dumped it in the belly dump trucks transporting mill material back to the stockpiles. This practice was discontinued after the first or second day and material was discarded by other means. Photos 14 thru 16 show the brooms used in the construction.

The ADOT 1 milled surface was found to have a large amount of the stripping at the interface between old pavement layers. In this section the stripping covers almost the entire area except for in the last 100 feet of the SHRP 040507 section.

Tacking Process

SS-1h emulsion was applied for tacking at a rate of .0.1 gallon per square yard. The breaking time of this emulsion was 5 to 15 minutes depending on the ambient air temperature of the day. This information was collected from the contractor and ADOT project history. Photos 17 and 18 show the tacked surface.

Photo 2- Milling Macine Used in Milling

Photo 3- Milling Machine with the Water truck

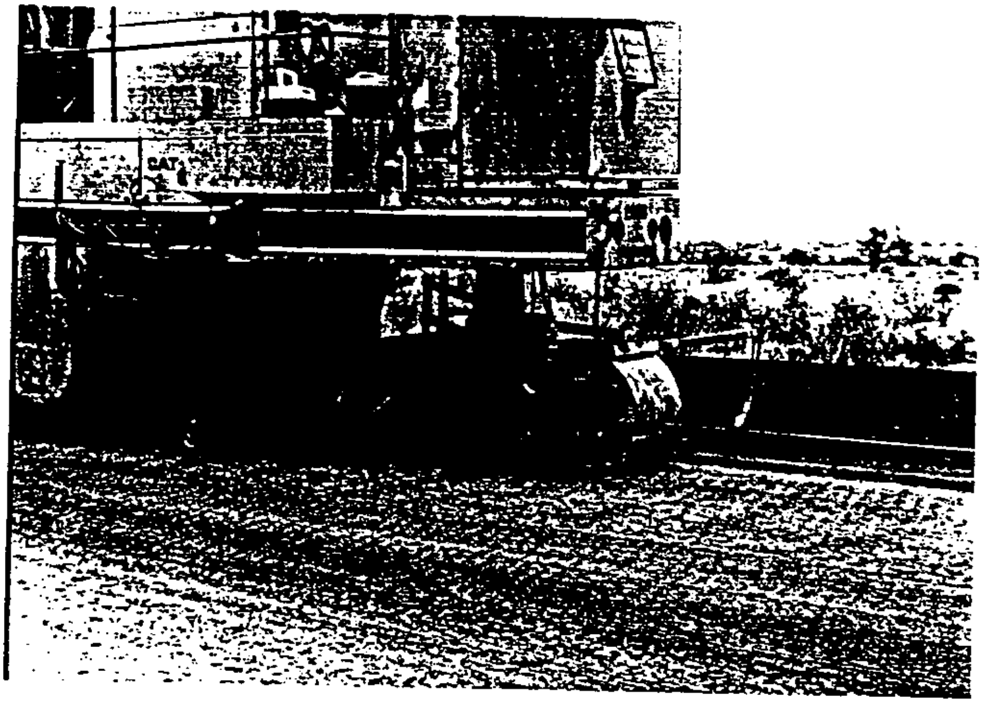

Photo 4- Milling Process

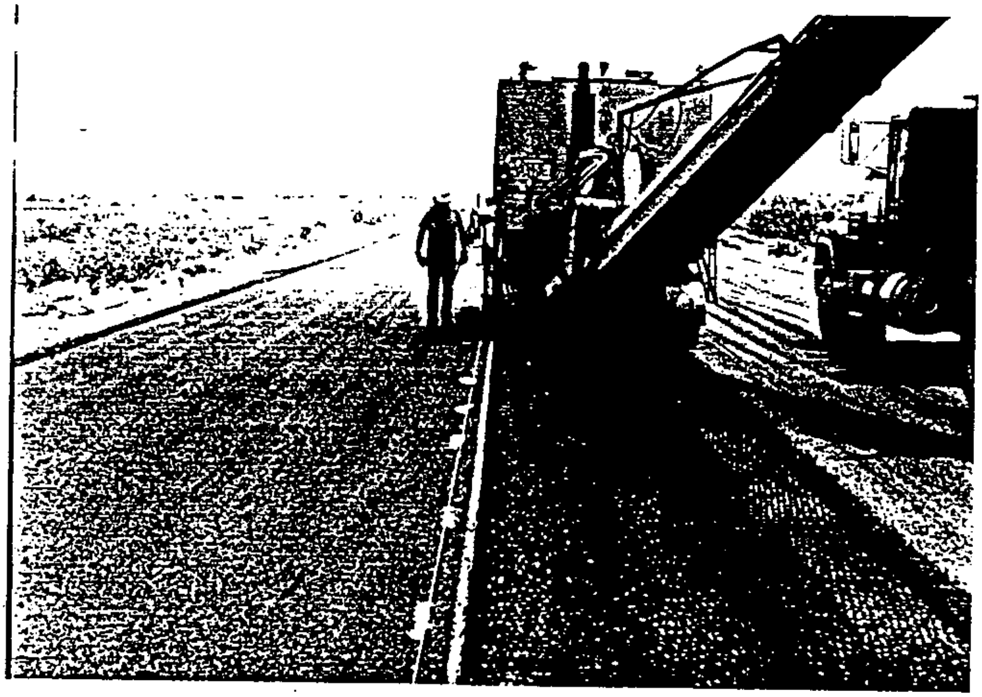

Photo 5- Milling Process

Photo 6- Collection of Milled Material

Photo 7- Collection of Milled Material

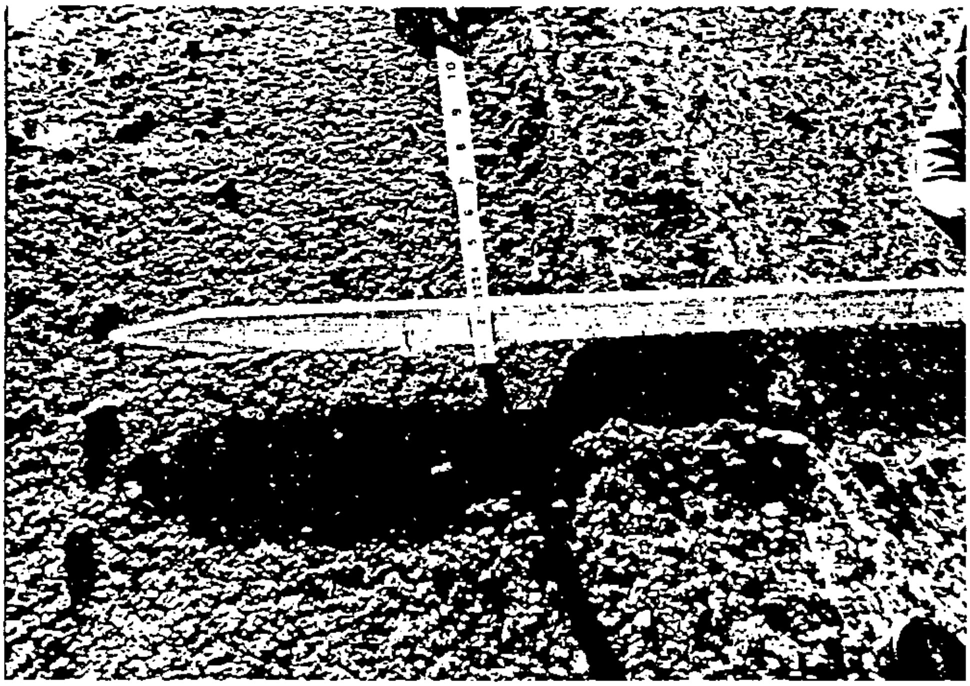

Photo 12- Differential Mill Depth Measurement

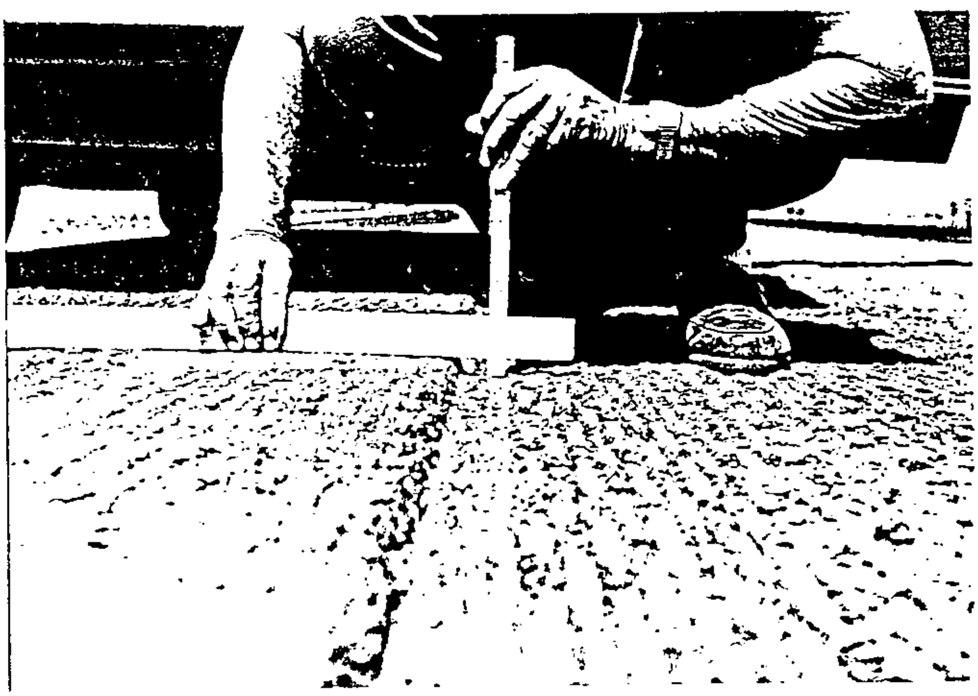

Photo 13- Final Mill Depth Measurement

Photo 14- Brooming of Milled section

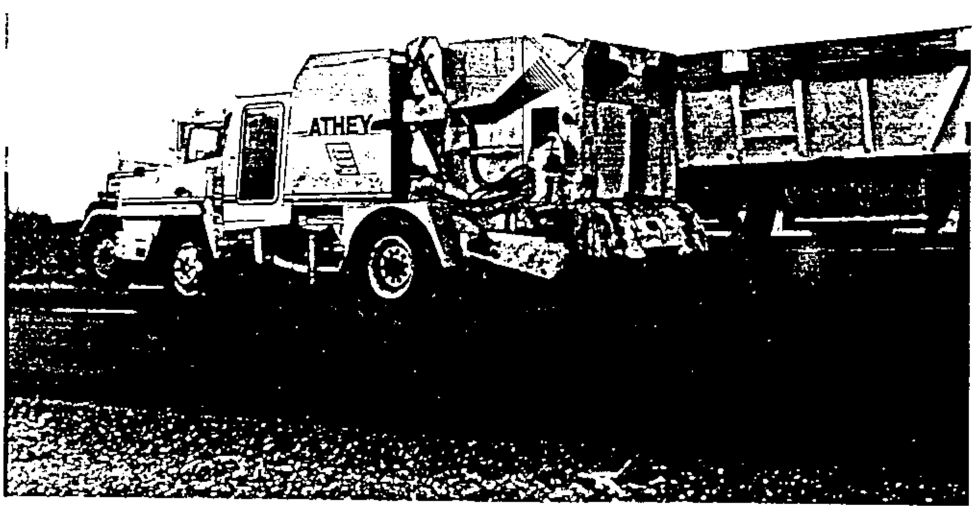

Photo 15- Brooming of Milled Section

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Photo 16- Collection of Milled Material by Pickup Broom.

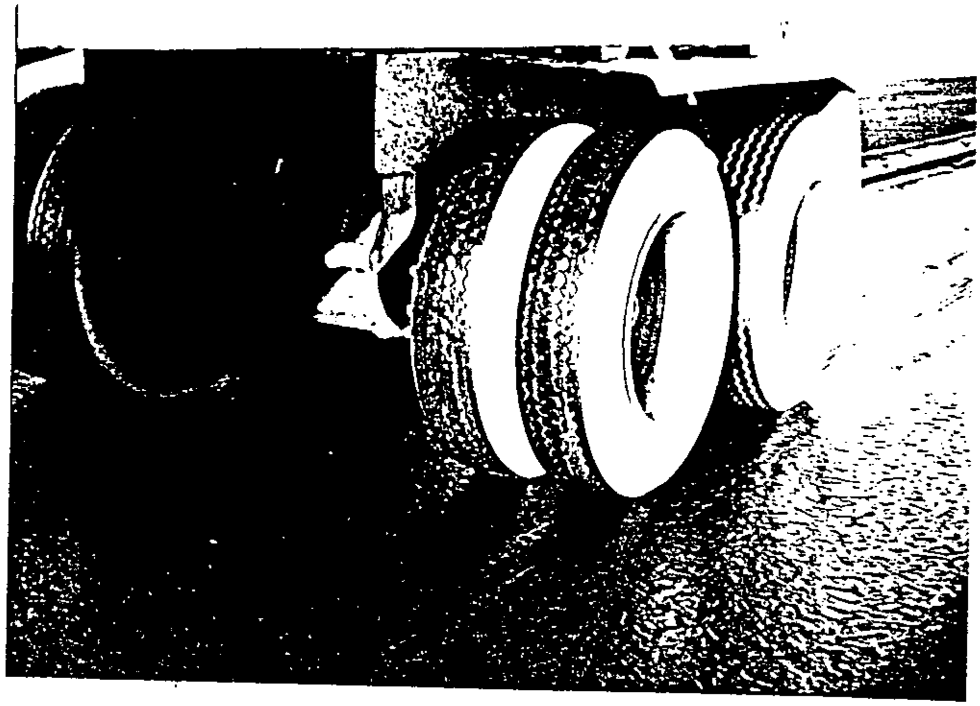

Photo 17- Tacked Surface

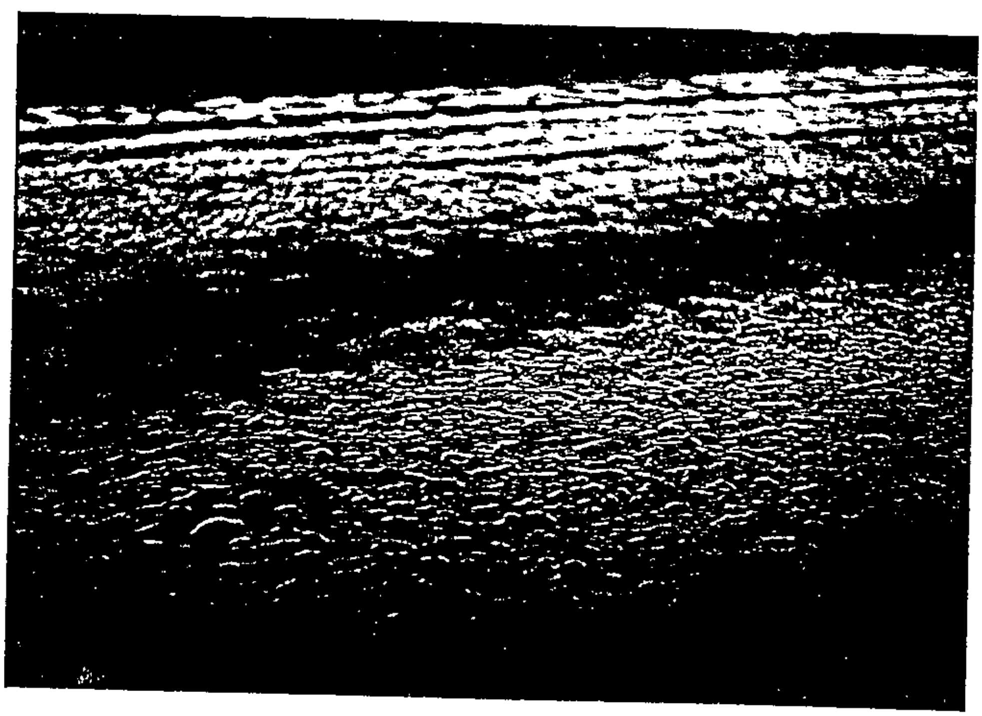

Photo 18- Tacked Surface

Paving Layout

The paving was planned to be done in three lifts for both right and left lanes. The paving plan for this section has been shown in Figures P1, P2 and P3. Table 25 shows a summary of the paving plan.

Paving Process

The paving of ADOT 1 started on May 16, 1990. The type of paver used by the contractor was a Blaw-Knox PF-220 paver. Three identical pavers were used on the project; however, only two were ever used in the SHRP sections. Paving of ADOT 1 was the first day of work in the End Product sections. On the previous day (5/15/90), 3777 tons of end product had been paved in a non-SHRP section of the project which is close to the ADOT requirement of 4000 Tons prior to reaching SHRP sections. The right lane was paved first to be consistent with traffic control needs elsewhere on the project. Photos 19 thru 24 show the paver and the paving operation.

TABLE 25- SUMMARY OF PAVING PLAN FOR ADOT 1

Lane	Date	Day	Lift
RIGHT	5/16/90	8	1/3
	5/22/90	12	2/3
	5/24/90	14	3/3
LEFT	5/18/90	10	1/3
	5/21/90	11	2/3
	5/23/90	13	3/3

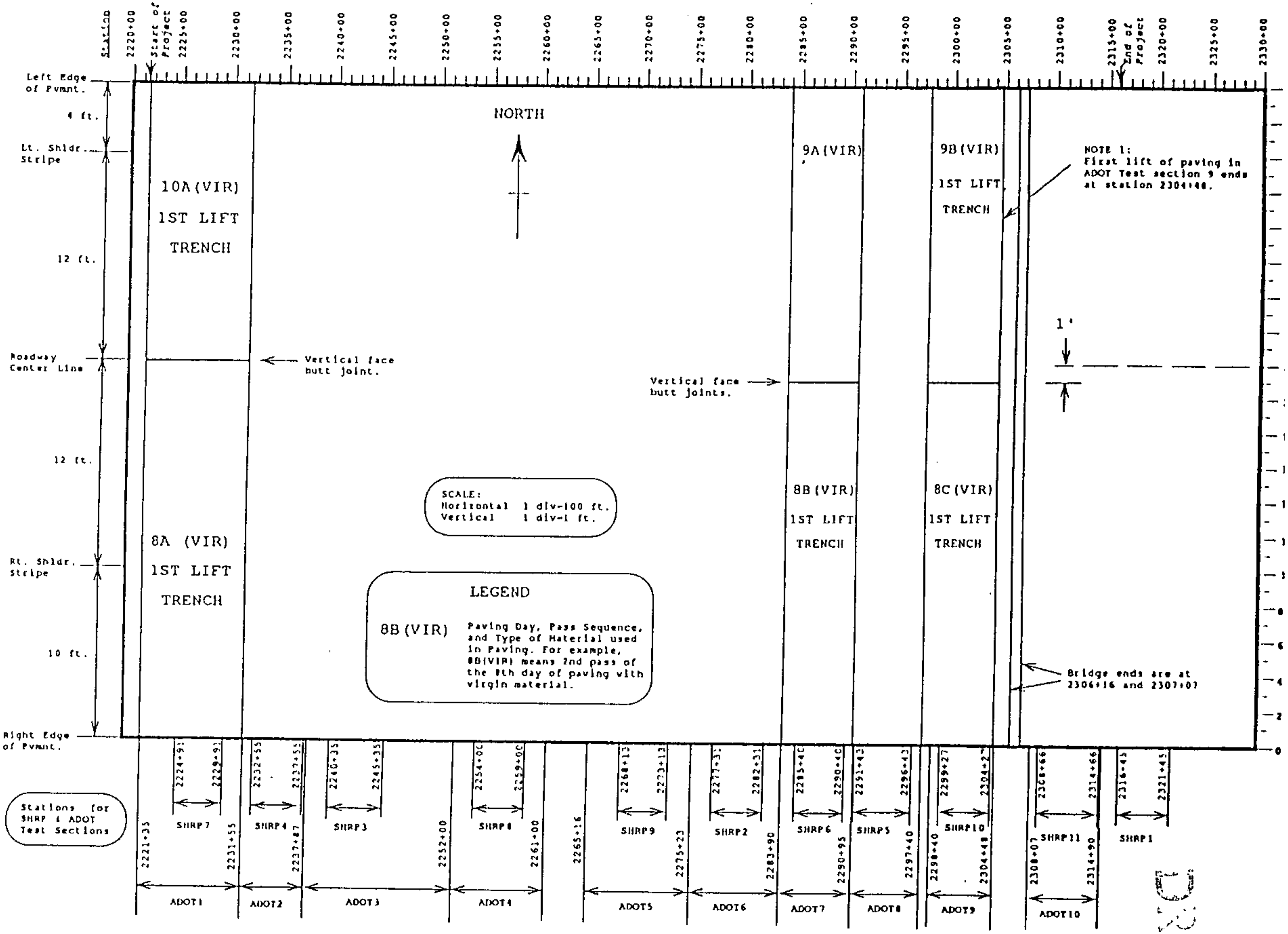

Figure P1- Paving Plan for Sections 1, 6 and 10

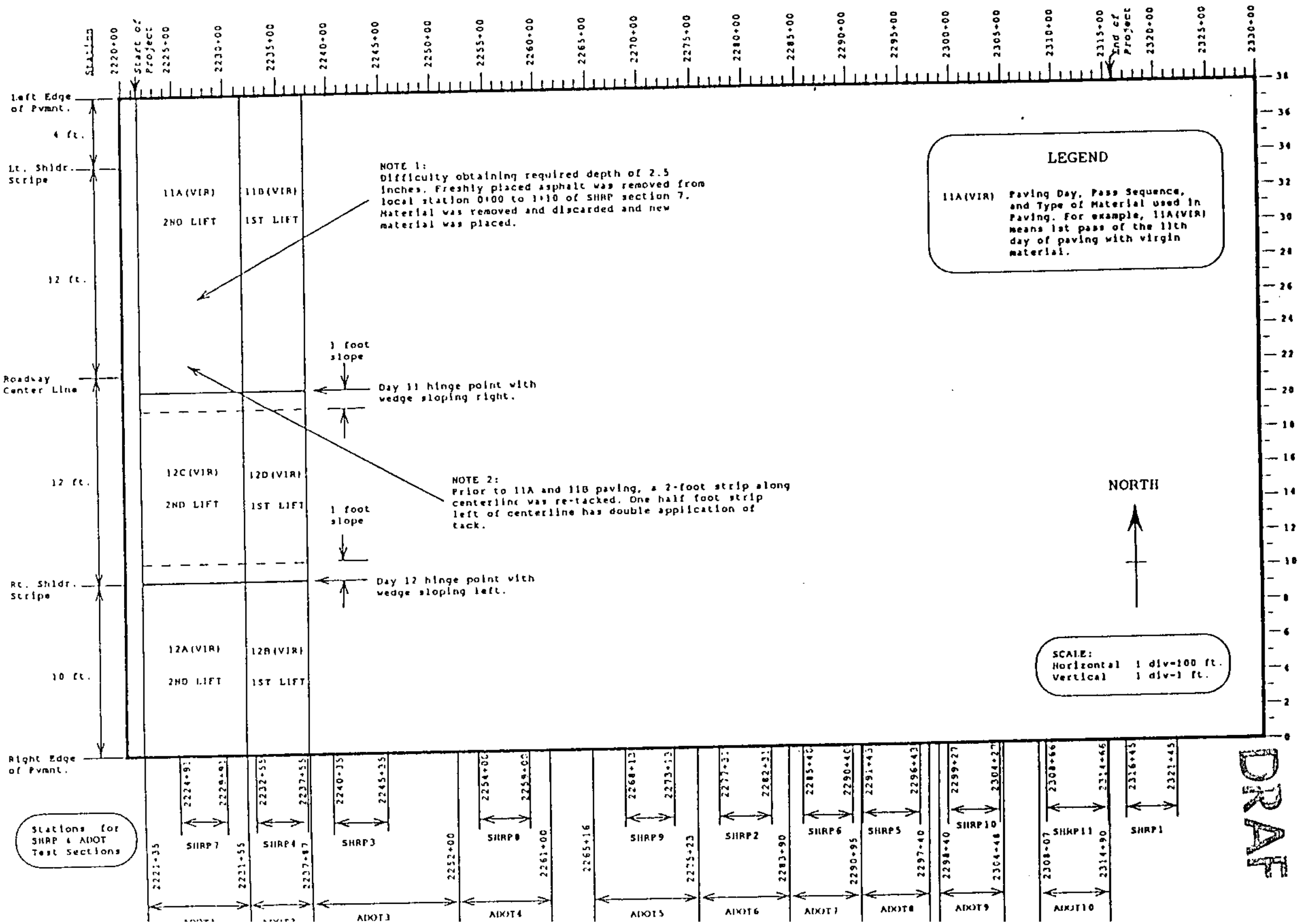

Figure P2- Paving Plan for Sections 1 & 2

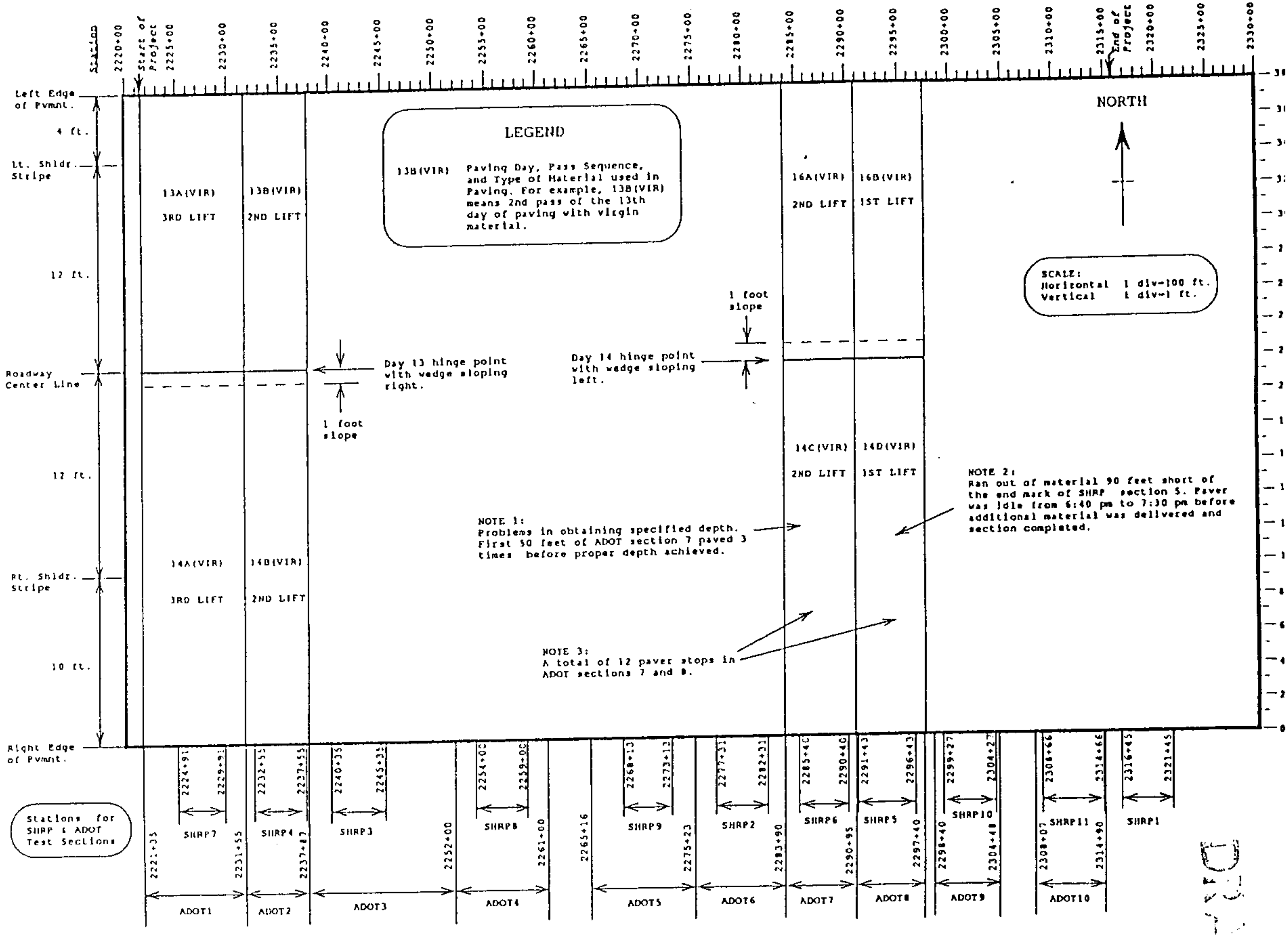

Figure P3- Paving Plan for Sections 1, 2, 7 & 8

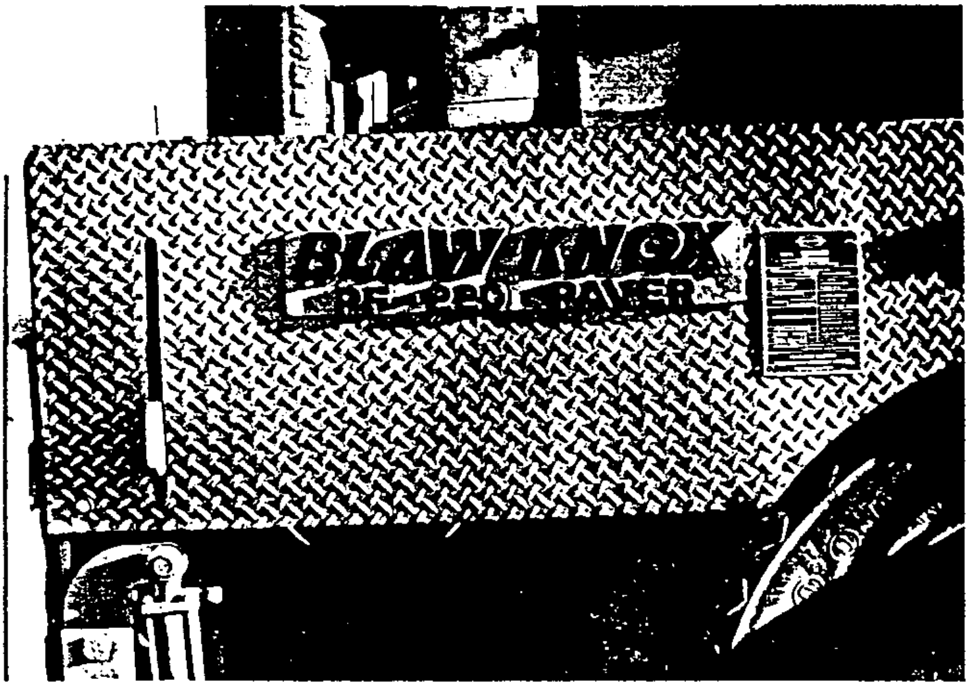

Photo 19- Close-up of Paver

Photo 20- Asphalt Concrete Placement

Paving of lift 1 of 3 on the right lane of ADOT 1 began at 1:15 P.M. and was through the end by 2:30 P.M.. The windrow temperature was around 240 degrees. The average temperature behind the paver was 225 degrees. This was a concern; however, the project people informed ATRC personnel that temperatures for end product were not controllable by ADOT. The contractor experienced a very low temperature on the I-10 paving job which they had recently completed without having a compaction problem. The uncompacted depth ranged from 2-7/8 inches to 3-1/4 inches and compacted depth ranged from 2-1/4 inches to 2-3/4 inches. The depth measurements were made by pushing the new pavement with the temperature probe and measuring the penetration. This was not a sophisticated method, but it was quick and it did give an indication of actual depths. The problem with this method was that the probe can either drop into a depression or stop on a rock and give an erroneous measurement. Lifts that were first ribbons can be measured with respect to the unpaved section next to it, but second ribbons can only be measured with the "probe" method. Thus the measured depths should only be considered as approximate depths. However, due to lack of coring on SHRP sections, these depths were considered as final depths. Photos 25 and 26 show the uncompacted and compacted depth measurements.

The compaction was done with a steel drum roller. Photos 27 and 28 show the roller and compaction process. Unless otherwise mentioned, only one steel drum roller was used on all SHRP sections. The mat temperature was 220 degrees when rolling was done reached at the end of SHRP 040507. Compared to later in the project, this temperature was high. Local station 1+90 to 2+50 of SHRP 040507 had a 1/4 inch to 1/2 inch longitudinal hump at 12 feet right of the roadway centerline. In this area the roller missed a portion and never got back to smooth it out. This hump was not noticed after this day.

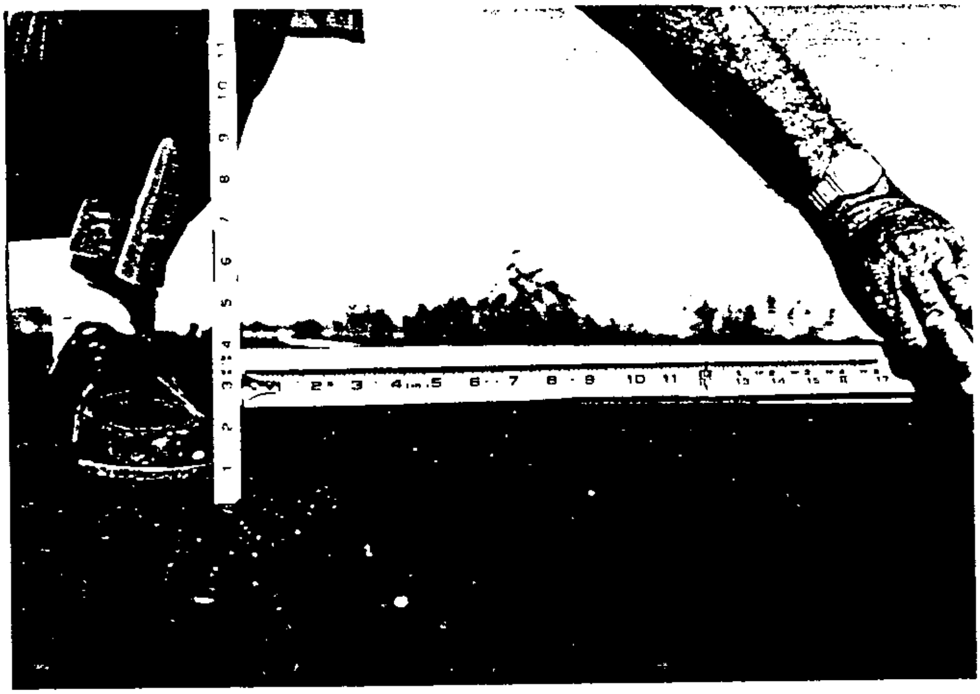

Photo 25- Uncompacted Depth Measurement

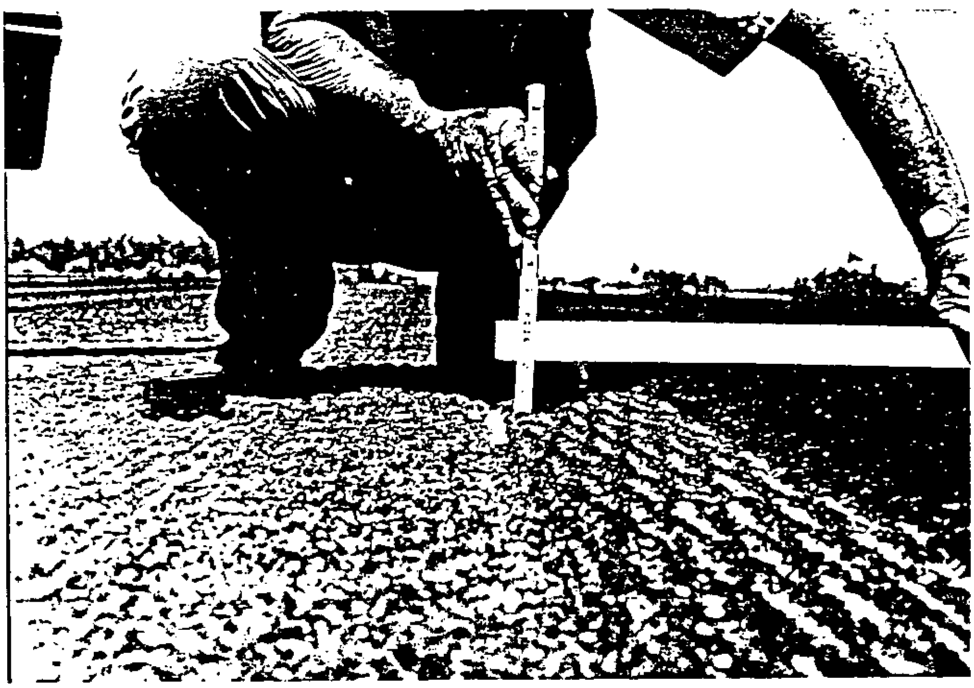

Photo 26-Compacted Depth Measurement

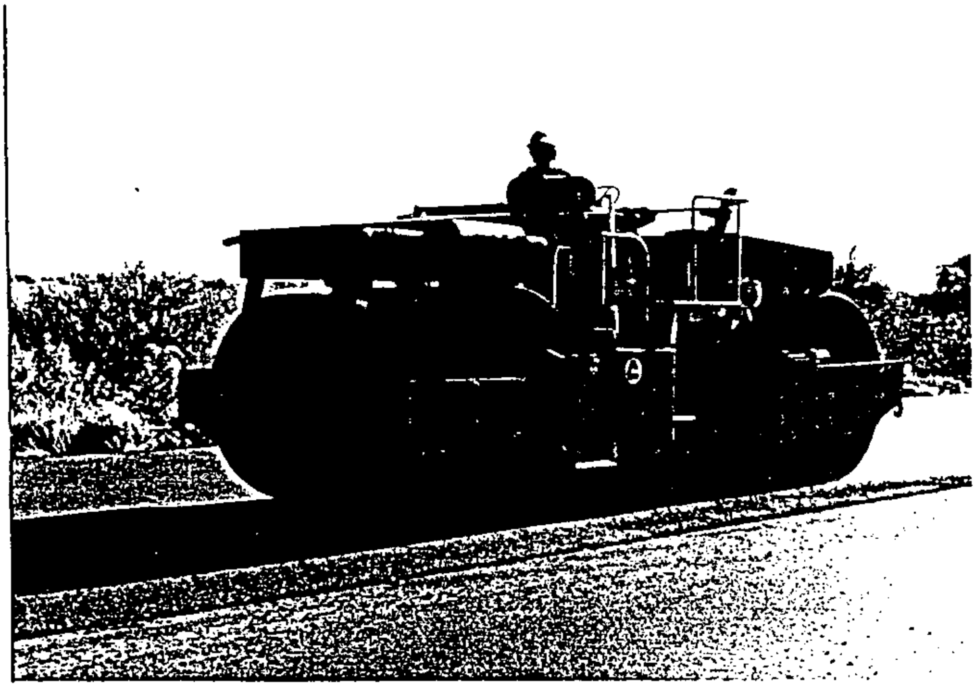

Photo 27- Steel Drum Roller Used in Rolling

Photo 28- Rolling Process

On May 18, paving of lift 1 of 3 on the left lane of ADOT 1 was done. The paving began at 4:30 P.M. and was complete by 5:15 P.M.. The temperature behind the paver averaged 223 degrees throughout most but was as low as 212 degrees at the end. The uncompacted depth was consistently 2-3/4 inches and ranged from 2-1/4 inches to 2-5/8 inches deep after compaction.

The inner shoulder was paved about a foot wide. That put a foot of the pavement on the soft shoulder material. Prior to paving on the next day it was noticed that along the entire length of this section the 1 foot strip which had no support was cracked longitudinally.

The lift 2 of 3 on the left lane was paved on May 21. Prior to paving, the contractor was held up at the request of the ATRC so that nuclear densities could be obtained. Since ADOT did not have a person or a gage on the job, the contractor's gage was used for measuring in-situ densities.

The paving used the first 250 feet to taper from 0 inch depth to 2-1/2 inches depth by taking the advantage of enough space in front of ADOT 1. This was necessary because ADOT 1 was at very beginning of test sections. After reaching the proper depth the actual SHRP section 040507 was entered. By local station 1+10 the contractor realized that the depth was too shallow and started removing material behind the paver all the way back to local station 0+50. He planned to simply repave this but was reminded by ATRC personnel that there are no transverse joints allowed in SHRP 500 feet test sections and that he had to remove the material all the way back to 20 feet prior to SHRP section 040507. Material was scraped up off the roadway and dumped into the back of belly dump trucks that still had their loads. This was also not acceptable and the contractor ended up contaminating 3 full truckloads of material which had to be rejected. This whole process took from 11:30 A.M. to 12:15 P.M.. A transverse joint does exist in this 2nd lift of ADOT 1 which is 20 feet ahead of the actual 500 feet section beginning.

Finally, ADOT 1 was paved between 12:30 P.M. and 1:15 P.M.. The temperature behind the paver was between 221 degrees and 226 degrees. Lower readings were obtained but these were from just prior to the section where material had been sitting during the removal of some of the pavement. The uncompacted depth was between 3-1/8 inches and 3.5 inches and compacted depths ranged between 2.75 inches to 3.25 inches. There was discussion at this time about adjusting the depth of the lift that would be placed on top of this section but it was decided against. The reason was that the depths could not be relied upon enough to warrant using a thinner lift on top.

Prior to this day there had been a great deal of confusion about the nuclear density readings. The operator was Gene Pena through Day 9. The End Product material started on Day 8. The two problems were that 1) a new correction factor had to be established for the End Product material, and 2) on Day 10 no ADOT gage operator showed up and on Day 11 a new operator showed up and added an arbitrary 5 pcf correction into the Troxler 4640B density gage. On this day, Day 11, a new correction factor was determined from readings taken at the 10 compliance core locations. The correction factor determined was 2.0 pcf for End Product as opposed to the 2.4 pcf for the Recycle. This 2 pcf is applicable to all End Product paved between Day 8 and Day 14. The compliance calculations used this 2 pcf and subtracted out the 5 pcf only where data sheets noted that it was added in. The validity of this was confirmed with the operators.

The lift 2 of 3 on the right lane of ADOT 1 was paved in two ribbons on May 22, 1990. The right ribbon was the first and extended over the 10 foot shoulder and had a 1 foot wedge sloping left. The second ribbon filled in between the wedges of the left lane and the shoulder ribbon. On the second ribbon, the paver drove with the large wheel of the paver riding on the slope of the left lane. This may or may not have increased the density.

The right shoulder ribbon was paved between 8:30 A.M. and 10:15 A.M.. The second ribbon of ADOT 1 was paved between 10:30 A.M. and 11:00 A.M.. The temperature behind the paver was between 199 degrees and 210 degrees. The time to final compaction was typically on the order of 1 hour at which time the temperatures had decreased by 50 degrees.

Placement of the top lift on ADOT 1 began on May 23, 1990 at 6:00 A.M.. and was complete by 6:45 A.M... The temperature in the windrow was 237 degrees and ranged between 217 degrees and 236 degrees behind the paver. The uncompacted depth ranged between 3 inches and 3-1/4 inches. After the first couple of roller passes and approximately 45 minutes later the temperature in the mat ranged between 160 degrees and 182 degrees. The compacted depth ranged between 2-3/8 inches and 2-1/2 inches.

The top lift of right lane of ADOT 1 was placed on May 24, 1990. Paving was not scheduled to start until 2:00 P.M. so that mainline right lane paving into SHRP paving could be a continuous operation. SHRP was not reached until after 3:00 P.M.. The right lane of ADOT 1 was paved against the left lane which had already been paved.

The paving began at 3:20 P.M. and the end was reached by 3:55 P.M.. The temperature ranged between 205 degrees and 221 degrees behind the paver. The uncompacted depth ranged between 2.75 inches and 3 inches. Approximately 50 minutes later, the temperature ranged between 155 degrees and 164 degrees and the compacted depth ranged between 2-1/4 inches and 2-3/4 inches. Table 26 shows the summary of the paving of ADOT 1 as well as compliance with the density requirements. The P_T value or the Total Percentage of the lot within Upper Limit (UL) and Lower Limit (LL) was calculated as below:

The Target Value of the density was 98.0 percent of laboratory density.

UL = TV + 4.5 pcf

LL = TV - 4.5 pcf

Upper Quality Index = (UL - AVE)/s where AVE= Average density of a lot and s= Standard Deviation.

Lower Quality Index = (AVE - LL)/s where AVE= Average density of a lot and s= Standard Deviation.

P_T = (PU + PL) -100 where PU and PL were determined from Table 406-7 of ADOT Standard Specification for Road and Bridge Construction (4).

SAMPLING

The material sampling for the End Product material was done on May 18, 1990. Samples taken at the plant and off the grade were:

(2) 55 gallon drums MA already blended. This obtained in same way as MA for recycle was obtained. (Sent to SHRP)

(11) 5 gallon buckets of AC-40 used for the End Product. (Sent to SHRP)

(3) 5 gallon samples of mix (actually 1/2 bucket) off the grade at end of ADOT 1. (one of these was used by project for compliance, one was sent to SHRP, and the other one is currently with ATRC).

TABLE 26- SUMMARY OF PAVING ON ADOT 1

Lane	Lift	SHRP Tonnage	Compacted Depth (in)	Gage/Point/Density (pcf)	P_T (%)
Right	1/3	307	2 1/4-2 3/4	1/A/139.3	98
	2/3	302	2 3/8-2 5/8	1/A/139.3	90
	3/3	302	2 1/4-2 3/4	1/A/137.8	70
Left	1/3	255	2 1/4-2 5/8	3/C/138.4	99
	2/3	275	≈ 3.0	1/A/134.4	42
	3/3	279	2 3/8-2 1/2	1/A/139.2	98

Notes:

1. Gage: 1: Troxler Troxler 4640B (Thin Lift)
   3: Seaman C-200 (Contractor)
2. Points: A: 3', 6'& 9'transverse @100' interval, 18 points
   C: only 1 of 3', 6'& 9'transverse @100' interval, 6 points

CONSTRUCTION OF TEST SECTION 2 (ADOT 2 & SHRP 040504)

The ADOT 2 was milled and paved during days 8, 10, 11, 12, 13, and 14 of the 17-day work on SHRP test sections. The work consisted of milling two lanes of the existing pavement and paving with end-product asphalt concrete in two lifts. The overlay thickness was 5 inches with minimal milling.

Milling Layout

The milling sequence is shown in Figure M1 and the milling depths are shown in Table M2. The pass sequence in Table M2 refers to milling sequence in Figure M1. Table 27 shows the mill depths for the two lanes and corresponding dates of milling.

TABLE M-2- Measured Depths of Milling in ADOT's Test Section 2

Transverse Location, Feet	Depth of Milling, Inches — Longitudinal Location Along SHRP Test Section, Feet						Average Milled Depth	Pass
	0	100	200	300	400	500		
10	0	0	0	0	0	0	0	8D
16	1 1/8	1 1/8	1 1/8	7/8	1 1/8	1	1 1/8	8C
22	1 1/8	1 1/8	1 1/8	1 1/8	1	1	1 1/8	8C

Transverse location is reported in feet, measured from right edge of the east bound roadway.

TABLE 27- MILLING DEPTHS FOR ADOT 2 FOR DIFFERENT LANES

Lane	Date	Day	Range of Depth (in)
LEFT	5/18/90	10	around 1
RIGHT	5/16/90	8	7/8 - 1 1/8

Milling Process

The milling started on the right lane of ADOT 2 on May 16, 1990. The milling depth was too shallow on the first pass and the entire right lane was remilled. Figure M2 shows the remilling on the right lane. The depth of remilling was 1-1/8 inches. The milling on the left lane was accomplished on day 10. The estimated milling depth was around 1 inch. The milled surface was cleaned in the same way as was in ADOT 1.

Tacking Process

SS-1h emulsion was shot for tacking at a rate of 0.1 gallon per square yard. The break times of this emulsion was 5 to 15 minutes depending on the ambient air temperature of the day.

Paving Layout

The paving with virgin AC mix was planned to be done in two lifts for both right and left lanes. The paving plan for this section has been shown in Figures P2 and P3. Table 28 shows the summary of the paving plan.

TABLE 28- SUMMARY OF PAVING PLAN FOR ADOT 2

Lane	Date	Day	Lift
RIGHT	5/22/90	12	1/2
	5/24/90	14	2/2
LEFT	5/21/90	11	1/2
	5/23/90	13	2/2

Paving Process

The paving of lift 1 of 2 on the left lane started on May 21. The type of paver used by the contractor was a Blaw-Knox PF-220 paver. At 10:20 A.M. the contractor re-tacked a small strip along the center of the roadway in the ADOT 2 that would be under the sloped wedge after paving.

The tack overlapped the previous tack by no more than 6 inches so there is a 6-inch strip with double tack in ADOT 2 just left of the centerline. Paving began at 1:45 P.M. and continued until 2:30 P.M. The temperature behind the paver ranged from 206 degrees toward the middle to between 222 degrees and 234 degrees at the ends. The uncompacted depth ranged from 2-7/8 inches to 3-1/2 inches and the compacted depths were not measured. At local station 4+15 in SHRP 040504 the roller broke down until approximately 3:00 P.M. at which time the mat was 168 degrees. Rolling was finished at 3:20 P.M.. The temperatures of the mat was 149 degrees.

The right lane of ADOT 2 was paved on May 22 in two ribbons. The right ribbon was first and extended over the 10-foot shoulder and had a 1-foot wedge sloping left. The second ribbon filled in between the wedges of the left lane and the shoulder ribbon. It was noted that on the second ribbon, the paver drove with the large wheel of the paver riding on the slope of the left lane. This may or may not have increased the density.

The right shoulder ribbon was paved between 8:30 A.M. and 10:15 A.M. The second ribbon of ADOT 2 was paved between 11:00 A.M. and 11:30 A.M. The temperature behind the paver was between 206 degrees and 231 degrees. The time to final compaction was typically on the order of one hour at which time the temperatures had decreased by 50 degrees. The density was measured by a Troxler 4640B nuclear density gage. The gage was set on its 1-inch thick calibration plate for a 4-minute count 6 times. The average of all readings was 109.5 pcf with a standard deviation of 0.527 pcf. The target value was 110 pcf but a tolerance of ± 2.0 pcf was cited as acceptable by Troxler. It was presumed that the gage was working properly.

On day 14 (05/24/90), lift 2 of 2 of the right lane was paved. Paving began at 6:50 A.M. and was complete by 7:20 A.M. The temperature ranged between 221 degrees and 228 degrees behind the paver. The uncompacted depth ranged between 2-3/4 inches and 3 inches. After approximately 30 minutes later the temperature in the mat ranged between 170 degrees and 196 degrees. The compacted depth was 2-1/4 inches consistently.

CONSTRUCTION OF TEST SECTION 3 (ADOT 3 & SHRP 040503)

The ADOT 3 was milled and paved during days 3, 4, 5, and 7 of the 17-day work on SHRP test sections. The work consisted of milling two lanes of the existing pavement and paving with recycled asphalt concrete in two lifts. The overlay thickness was 2.5 inches with 2.5 inches milling.

Milling Layout

The milling sequence is shown in Figure M2 and the milling depths are shown in Table M3. The pass sequence in Table M1 refers to milling sequence in Figure M2. Table 30 shows the mill depths for the two lanes and corresponding dates of milling. In this section the mill depth understandably decreases to nearly zero at the shoulder stripe due to absence of the ACFC. That was a typical situation which showed how shallow mill sections looked prior to the remilling that was subsequently required. Section 3 was paved before the issue of inadequate milling surfaced and was never remilled. There appeared to be less rutting and alligator cracking prior to milling in this section compared to some of the later sections where remilling was required. This applies to this lane and to the right lane which was done on the next day (05/02/90). On this day, the milling in the right lane milled off a portion of the previous day's wedge; however, there was still at least 6 inches of unmilled pavement left under the unmilled portion of the wedge. This conclusion was verified visually. On the cross section view of the cut edge there was a layer of ACFC visible. Photos 29 thru 32 show this situation.

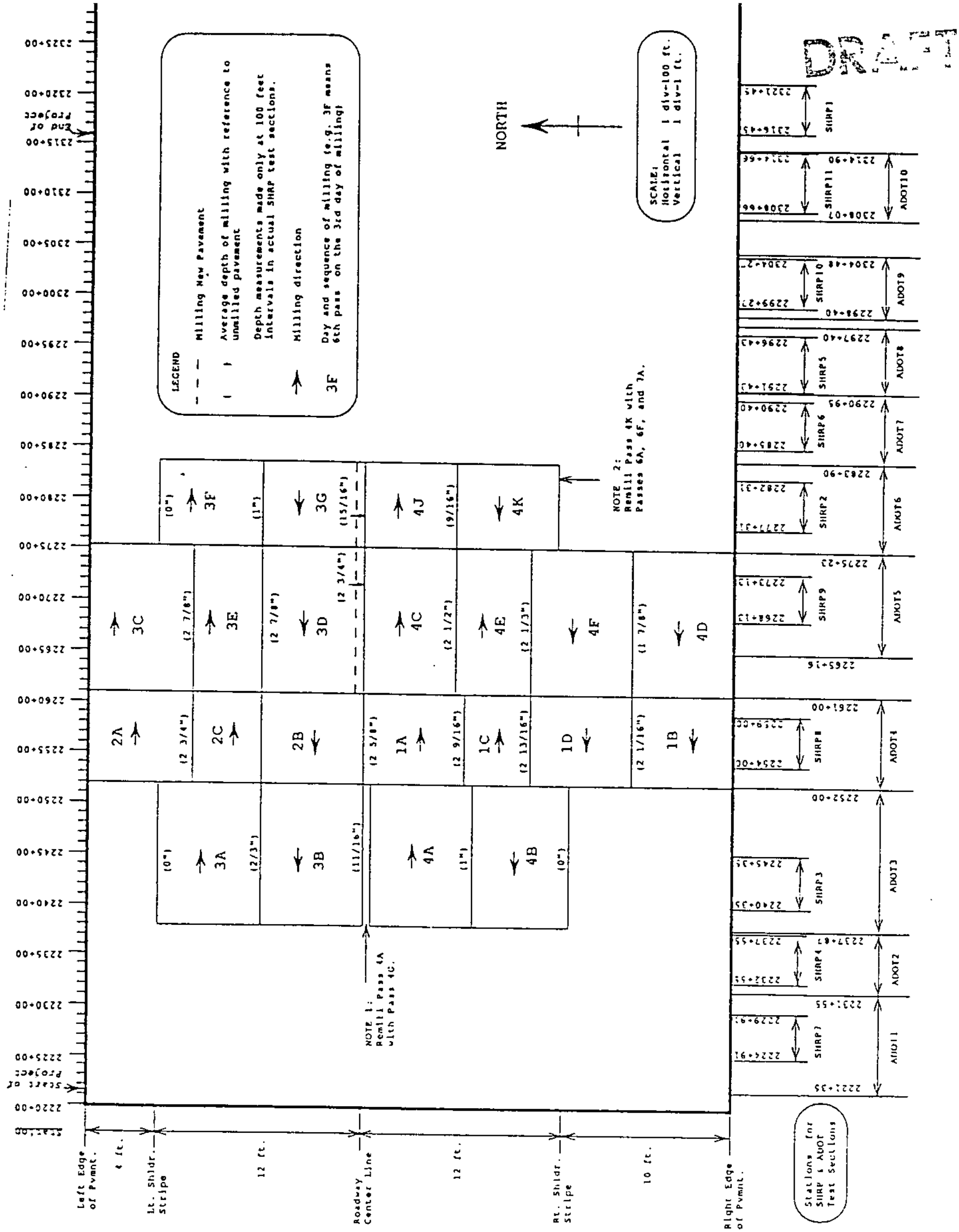

Figure M2- Milling Plan for Sections 3, 4, 5 and 6.

TABLE M-3- Measured Depths of Milling in ADOT's Test Section 3

Transverse Location, Feet	Depth of Milling, Inches — Longitudinal Location Along SHRP Test Section, Feet: 0	100	200	300	400	500	Average Milled Depth	Pass
9.5	0	0	0	0	0	0	0	4B
15.5	3/4	1	1 1/8	1	1	1 1/8	1	4A
21.5	(2 1/2)	(2 1/2)	(2 1/2)	(2 1/2)	(2 1/2)	(2 1/2)	(2 1/2)	4A
22	3/4	5/8	5/8	3/4	5/8	3/4	11/16	3B
28	5/8	5/8	5/8	3/4	5/8	3/4	2/3	3A
34	0	0	0	0	0	0	0	3A

Notes: 1. Numbers in parenthesis are depths of milling with reference to new pavement.
2. Transverse location is reported in feet, measured from right edge of the east bound roadway.

TABLE 30- MILLING DEPTHS FOR ADOT 3 FOR DIFFERENT LANES

Lane	Date	Day	Range of Depth (in)
LEFT	05/03/90	5	2 3/8- 3.0
RIGHT	05/02/90	4	2 3/8 - 2 5/8

Paving Layout

The paving was planned to be done in two lifts with recycled asphalt concrete on both right and left lanes. The paving plan for this section has been shown in Figures P4 and P5. Table 31 shows a summary of the paving plan.

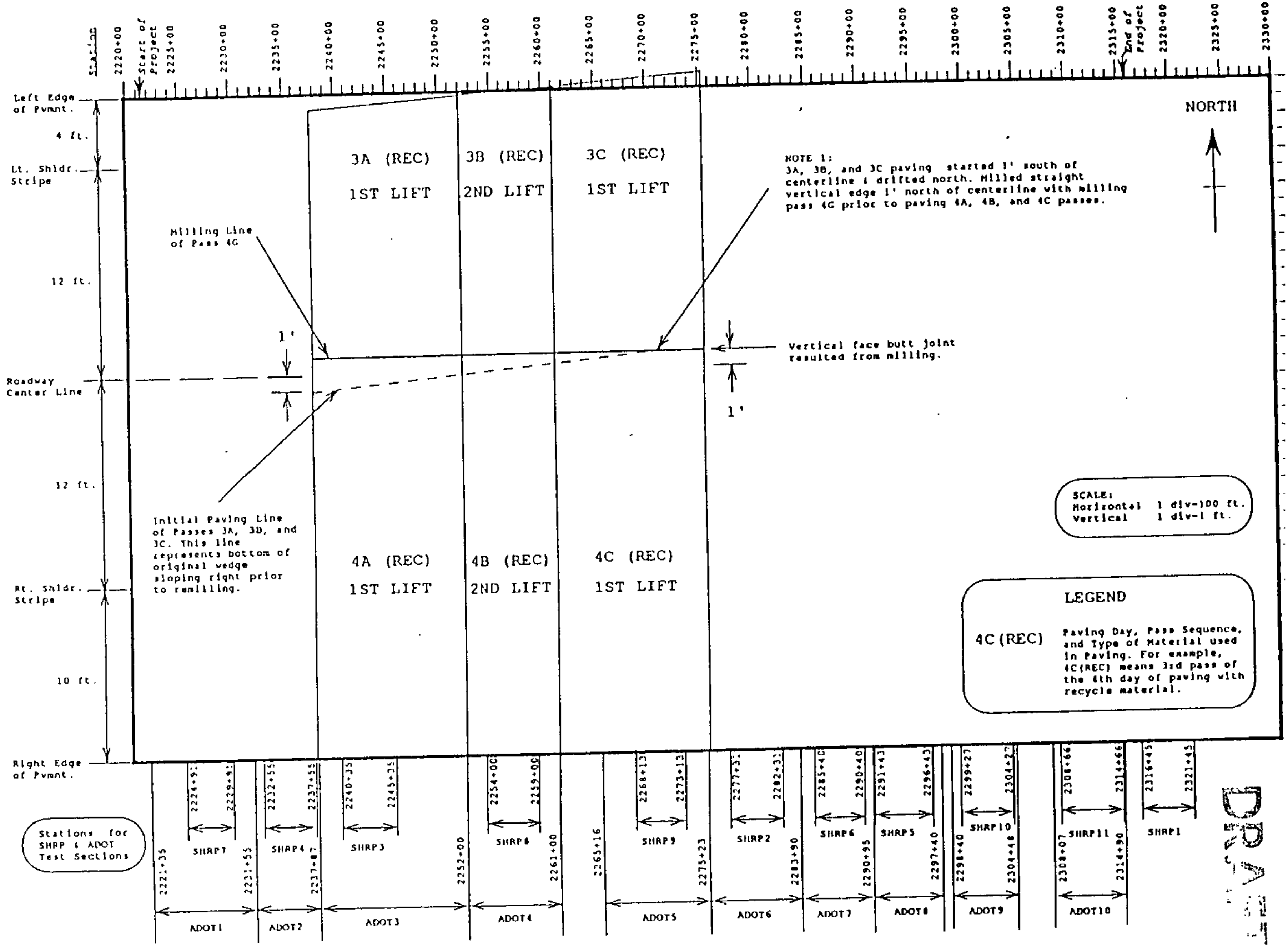

Figure P4- Paving Plan for Sections 3, 4 and 5

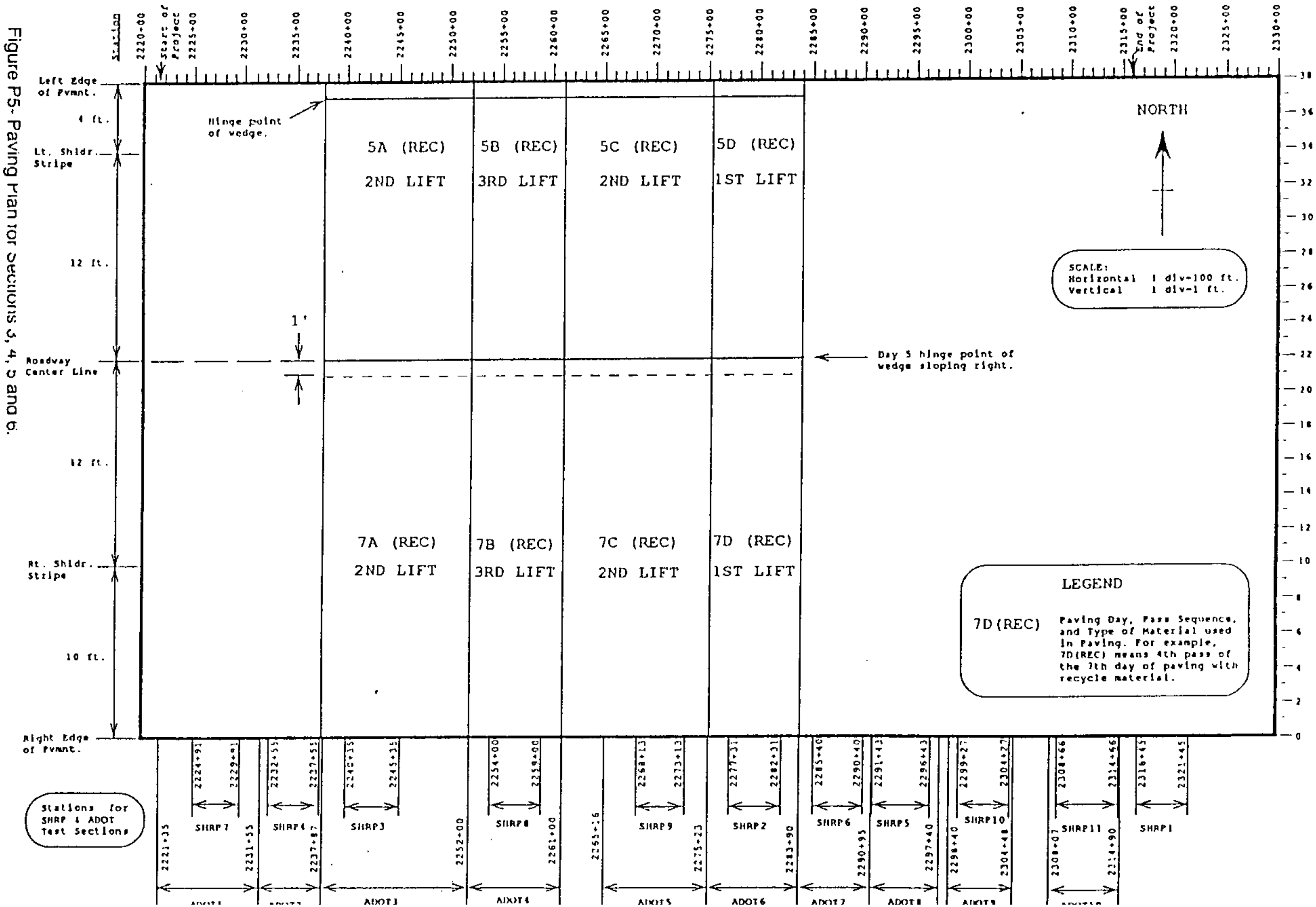

Figure P5- Paving Plan for Sections 3, 4, 5 and 6.

TABLE 31- SUMMARY OF PAVING PLAN FOR ADOT 3

Lane	Date	Day	Lift
RIGHT	5/02/90	4	1/2
	5/08/90	7	2/2
LEFT	5/01/90	3	1/2
	5/03/90	5	2/2

Paving Process

On May 1, 1990, paving started at the beginning of ADOT 3 placing lift 1 of 2 on the left lane at 2:20 P.M. and was completely placed, although not rolled, continued to the end of ADOT 4 by 4:30 P.M. and the end of ADOT 5 by 6:25 P.M.. The average temperature behind the paver was 252 degrees. The paver moved at approximately 25 feet per minute so the majority of the time the paver was not moving. Time gaps were generally between test sections and not inside. The overlay thickness was 2.5 inches. In the morning, the milling of ADOT section 3 started in relation to the paving of the previous day. The left half of sections 3 was paved on the previous day as shown in Figure P4. The continuous ribbon from the previous day was placed with a wedge having a hinge point beginning at the roadway centerline and directly above the location of the shallow mill milling line from the previous day. Since the adjacent right lane had not been milled prior to paving the left lane, the wedge extended into the right lane covering nearly one foot of unmilled pavement.

The contractor was immediately informed of this deficiency. The crew laid out a control line for remilling ADOT 3. The new line was located one foot to the left of the centerline as opposed to one foot to the right of the centerline as it had been. In order to make the longitudinal joints through ADOT 3 and other sections continuous, it was decided to continue the remill through ADOT sections 3, 4 and 5. Figure M3 shows the remilling plan.

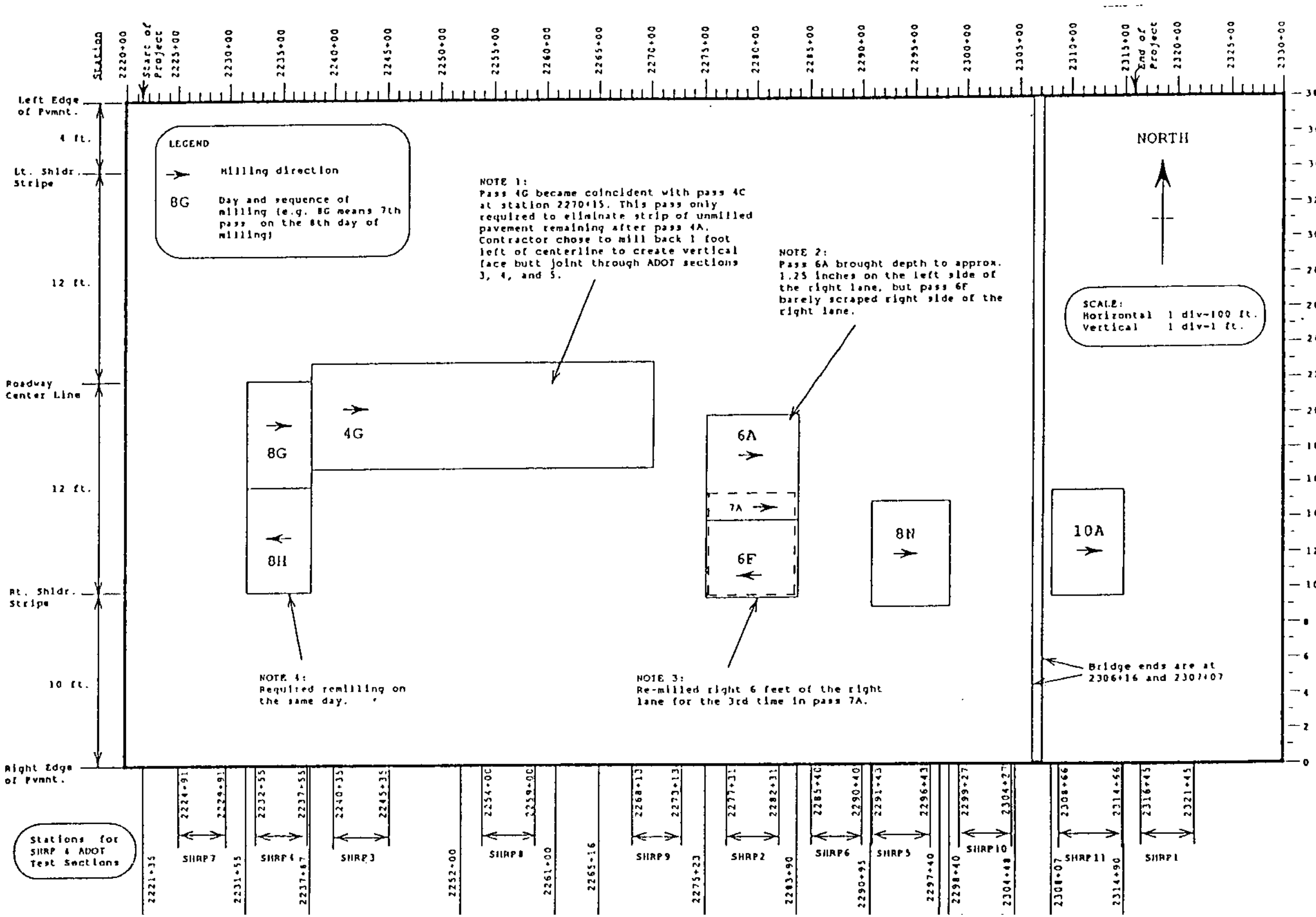

Figure M3- Remilling Plan for All Sections

While laying out the control line it was revealed that the ribbon placed previously had actually drifted a full two feet to the left by the time it reached the middle of ADOT 5 and then straightened out. Because of this, the remill pass 4G actually ended approximately 200 feet inside of SHRP section 9 at station 2270+15 where mill 4G became coincident with the first mill pass 4C. The 4G mill pass did not add any depth to the mill, it only cut back the wedge further than the first pass had cut it back.

On May 2 paving of lift 1 of 2 on the right lane began at 1:30 P.M. and completed after 2:30 P.M.. The average temperature behind the paver was 270 degrees and ranged from 265 degrees to 275 degrees. The uncompacted depth was 3 inches and the compacted depth was around 2.75 inches.

On May 3 paving of top lift of the left lane began at 7:30 A.M. and reached the end of ADOT 3 at 8:30 A.M.. The temperature at the beginning of the section was 275 degrees and was consistently 260 degrees throughout most of the rest of the section. The uncompacted depth was consistently 3 inches and compacted depth was 2.5 inches. There was a wedge sloping to the right. After rolling the slope was about 1 foot to 2.5 inches. Table 32 shows the summary of the paving of ADOT 3 as well as compliance with the density requirements.

TABLE 32- SUMMARY OF PAVING ON ADOT 3

Lane	Lift	SHRP Tonnage	Compacted Depth (in)	Gage/Point/Density (pcf)	P_T (%)
Right	1/2	438	2 5/8-2 7/8	1/A/142.5	90
	2/2	463	2 3/8-2 5/8	1/A/140.3	92
Left	1/2	-	≈ 2 1/2	-	-
	2/2	375	2 3/8-3.0	1/A/141.2	99

Notes:
1. Gage: 1: Troxler Troxler 4640B (Thin Lift)
2. Points: A: 3', 6'& 9'transverse @100' interval, 18 points

CONSTRUCTION OF TEST SECTION 4 (ADOT 4 & SHRP 040508)

The ADOT 4 was milled and paved during days 1, 2, 3, 4, 5, and 7 of the 17-day work on SHRP test sections. The work consisted of milling two lanes of the existing pavement and paving with recycled asphalt concrete in two lifts. The overlay thickness was 5.0 inches with 2.0 inches milling.

Milling Layout and Process

The milling sequence is shown in Figure M2 and the milling depths are shown in Table M4. The pass sequence in Table M4 refers to milling sequence in Figure M2. Table 33 shows the mill depths for the two lanes and corresponding dates of milling. The milling depth on this section was chosen to be 2-3/4 inches so that it would be 2 inches greater than the minimum restoration depth of 0.75 inch. The original SHRP specification was depths of 0.5 inch and 2.5 inches for minimum and maximum restoration respectively.

TABLE M-4 Measured Depths of Milling in ADOT's Test Section 4

Transverse Location, Feet	Depth of Milling, Inches — Longitudinal Location Along SHRP Test Section, Feet						Average Milled Depth	Pass
	0	100	200	300	400	500		
6	2 1/4	1 3/4	1 3/4	2 3/8	2	2 1/4	2 1/16	1B
12	2 3/4	3	2 3/4	2 3/4	2 7/8	2 3/4	2 13/16	1C
16	2 1/4	2 5/8	2 1/2	2 3/4	2 5/8	2 5/8	2 9/16	1A
22	2 3/8	2 5/8	2 5/8	2 3/4	2 5/8	2 3/4	2 5/8	1A
22	(2 5/8)	(2 1/4)	(2 3/4)	(2 1/2)	(2)	(2 1/4)	(2 3/8)	2B
32	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4	2A

Notes: 1. Numbers in parenthesis are depths of milling with reference to new pavement.
2. Transverse location is reported in feet, measured from right edge of the east bound roadway.

Photo 33- Cracked Pavement before Milling

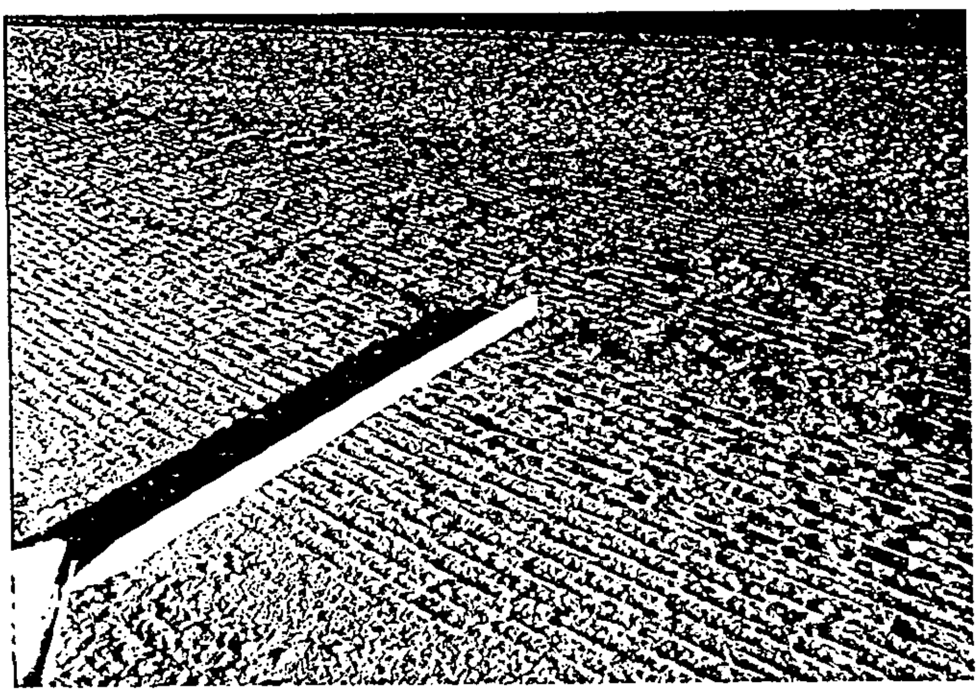

Photo 34- Cracked Pavement after Milling

Tacking Process

SS-1h emulsion was shot for tacking at a rate of 0.1 gallon per square yard. The break times of this emulsion was 5 to 15 minutes depending on the ambient air temperature of the day. It may be mentioned that ADOT 4 was constructed on the first day of work on SHRP sections. The tacking process was similar for all the test sections constructed later.

Paving Layout

The paving was planned to be done in three lifts for both right and left lanes. The paving plan for this section has been shown in Figures P4, P5 and P6. Table 34 shows a summary of the paving plan.

TABLE 34- SUMMARY OF PAVING PLAN FOR ADOT 4

Lane	Date	Day	Lift
RIGHT	04/25/90	1	1/3
	05/02/90	4	2/3
	05/08/90	7	3/3
LEFT	04/26/90	2	1/3
	05/01/90	3	2/3
	05/03/90	5	3/3

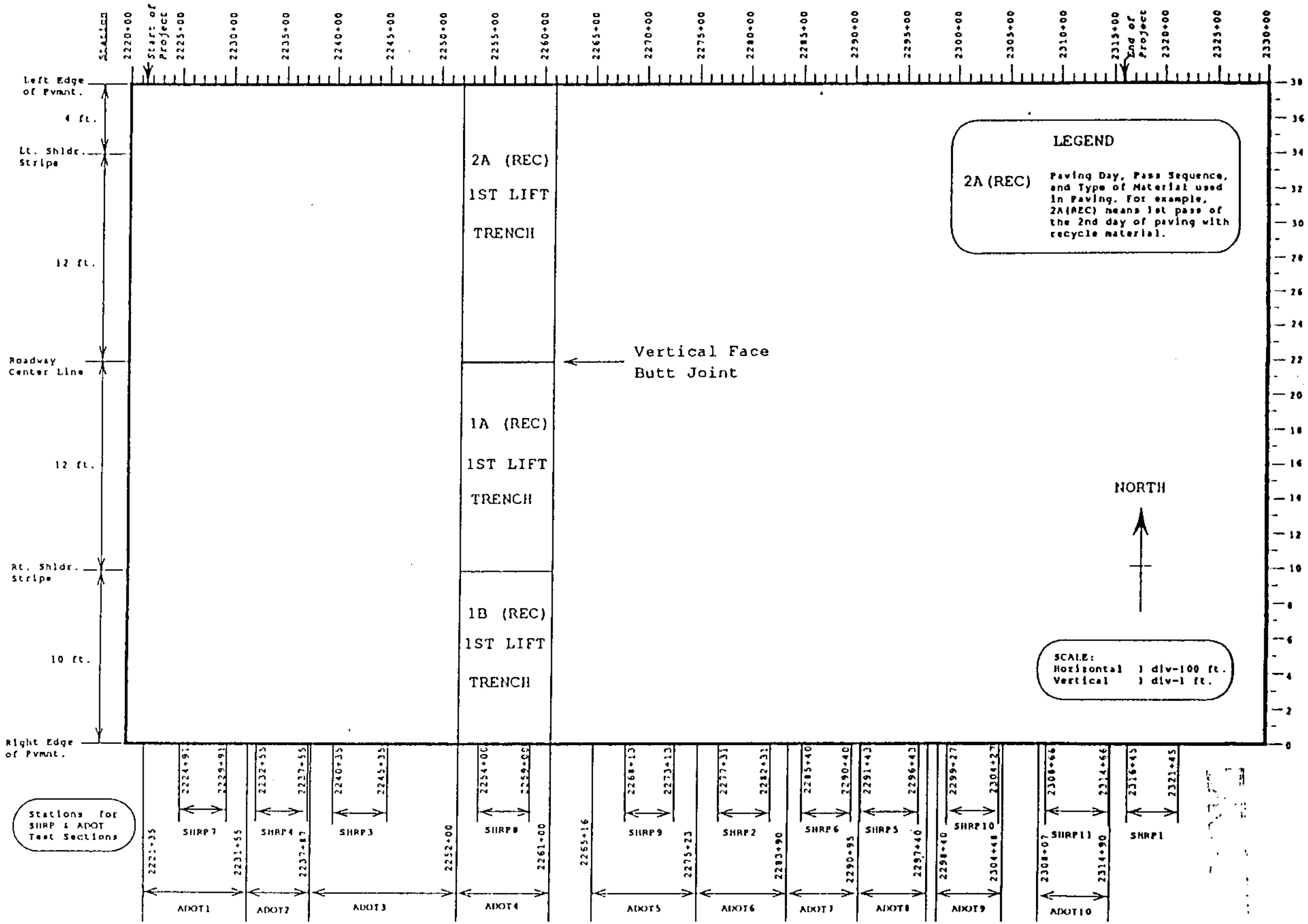

Figure P6- Paving Plan for Test Section 4

Paving Process

On April 24, 1990, paving started with the placement of lift 1 of 3 on the right lane. This is the first paving on the SHRP section. The average temperature of recycle material in the windrow was 265 degrees but ranged from 255 degrees to 285 degrees. All measurements taken behind the lay-down machine were between 255 degrees and 265 degrees. The compacted depth of the lift was 2 inches to 2.25 inches. No rolling pattern could be established.

After paving, a nuclear density gage experiment was performed. Earlier in the day three different Troxler nuclear gages were calibrated using the same cores taken from a non-SHRP portion of the project paved the previous day. The experiment consisted of getting nuclear density readings with all three gages at random locations on the right lane of ADOT 4. The ADOT gage used was Troxler Model 3411B (Serial 7083) from Casa Grande Construction. Two other gages were borrowed from Troxler. Those were Models 4545 (Continuous) and Model Troxler 4640B (Thin Lift). Cores were retrieved from the measurement loactions and densities were determined from the cores in the laboratory. A statistical analysis of the results showed that all gages were fairly consistent in density measurements. The mean density values obtained from gage measurements and mean density from laboratory test results of core samples were also similar. A detailed analysis report on this experiment appears in the Appendix G.

On day 2 (04/25/90) paving started on lift 1 of 3 on the left lane. Windrow temperatures were between 275 degrees and 280 degrees. The mat was compacted until the temperature was down around 150 to 175 degrees.

On day 3 (05/01/90), paving started at the beginning of ADOT 3 at 2:20 P.M. and was completely placed, although not rolled, to the end of ADOT 4 (lift 2 of 3 on the left lane) by 4:30 P.M. The average temperature behind the paver was 262 degrees. The paver moved at approximately 25 feet per minute so the majority of the time the paver was not moving. Time gaps were generally between test sections and not inside. The overlay thickness was 2.5 inches and changed to 2 inches on the next section. The 0.5 inch decrease was achieved gradually over the first 90 feet of the 432-foot milling transition used in this section.

On day 4 (05/02/90) paving of lift 2 of 3 on the right lane began at 3:30 P.M. on ADOT 4 and completed around 4:15 P.M.. The average temperature behind the paver was 263 degrees and ranged from 250 degrees at the beginning to 270 throughout the second half. The uncompacted depth was 3 inches and the compacted depth was around 2.75 inches.

On May 3, 1990, top lift of ADOT 4 on left lane was paved in one continuous ribbon. Paving began at 8:30 A.M. and reached the end of ADOT 4 by 9:30 A.M. The temperature was consistently between 250 degrees and 260 degrees. The uncompacted depth was 3 inches to 3-1/8 inches and the compacted depths ranged between 2.5 inches and 2.75 inches .

On May 8, paving of the top lift (3/3) on the right lane was completed. Table 35 shows the summary of the paving of ADOT 4 as well as compliance with the density requirements.

TABLE 35- SUMMARY OF PAVING ON ADOT 4

Lane	Lift	SHRP Tonnage	Compacted Depth (in)	Gage/Point/Density (pcf)	P_T (%)
Right	1/3	302	2 1/4-2 1/2	1/B/141.3	99
	2/3	258	2 3/4	1/A/139.2	98
	3/3	276	2 1/2-2 3/4	1/A/140.8	98
Left	1/3	166	≈ 2 1/4-2 1/2	2/C/136.5	53
	2/3	-	≈ 2 5/8	-	-
	3/3	375	2 1/4- 2 1/2	1/A/141.4	98

Notes:

1. Gage:
   1: Troxler Troxler 4640B (Thin Lift)
   2: Troxler 4645 (Continuous)

2. Points:
   A: 3', 6'& 9'transverse @100' interval, 18 points
   B: 10 random points, 10 points
   C: only 1 of 3', 6'& 9'transverse @100' interval, 6 points

CONSTRUCTION OF TEST SECTION 5 (ADOT 5 & SHRP 040509)

The ADOT 5 was milled and paved during days 3, 4, 5, and 7 of the 17-day work on SHRP test sections. The work consisted of milling two lanes of the existing pavement and paving with recycled asphalt concrete in two lifts. The overlay thickness was 2.0 inches with 2.0 inches milling.

Milling Layout and Process

The milling sequence is shown in Figure M2 and the milling depths are shown in Table M5. The pass sequence in Table M5 refers to milling sequence in Figure M2. Table 36 shows the mill depths for the two lanes and corresponding dates of milling.

The milling began on the left lane at station 2265+00 and tapered from 0 inch to 2.75 inches over 432 feet. It was noticed that 2.75 inches milling exposed the stripping at the old pavement interface. The stripping was more prominent in the wheel paths which were more distressed than other areas of the pavement. Photos 35 and 36 show this stripping.

On May 2, milling of ADOT 5 started in relation to the paving on the previous day. ADOT 5 was later remilled on the wedge as shown in Figure M3.

TABLE 36- RANGE IN MILLING DEPTHS FOR ADOT 5 FOR DIFFERENT LANES

Lane	Date	Day	Range of Depth (in)
LEFT	5/01/90	3	2 5/8 - 3.0
RIGHT	5/02/90	4	2 1/4 - 2 5/8

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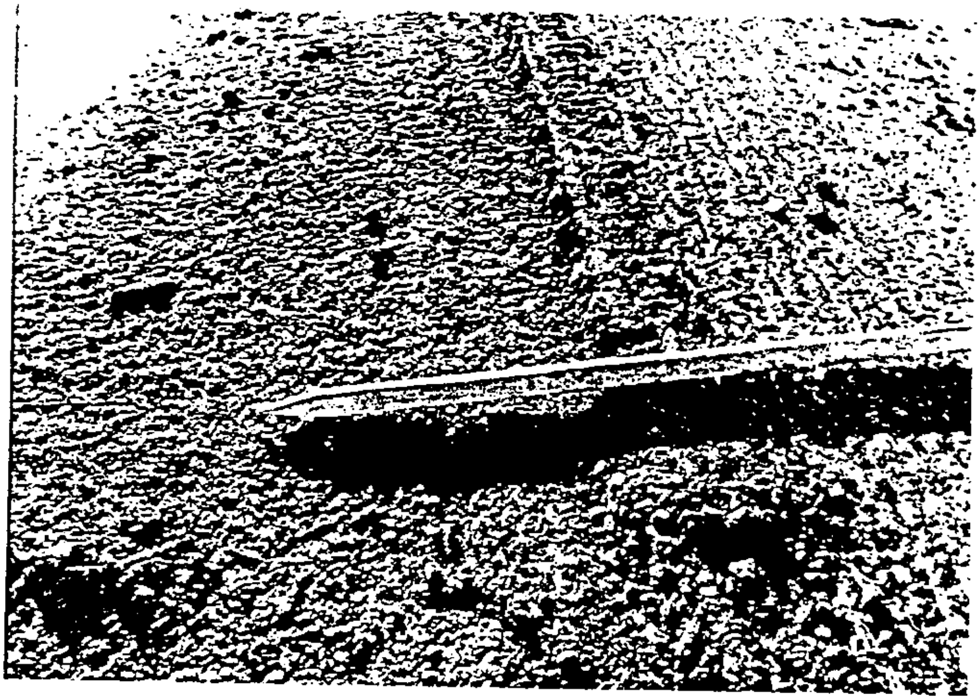

Photo 35- Stripping at Existing Pavement Lift Interface.

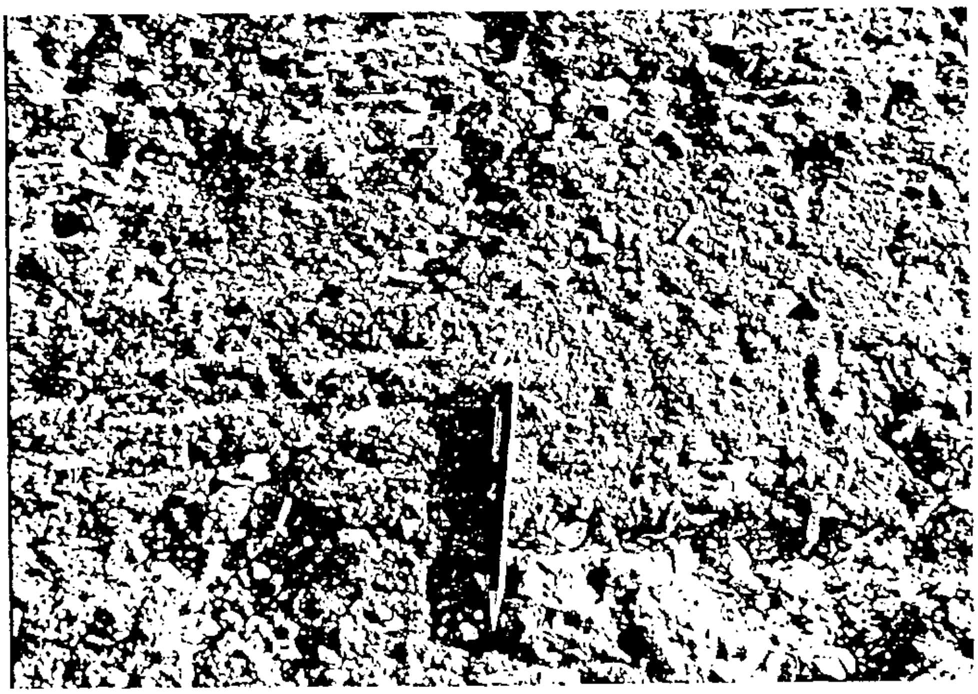

Photo 36- Close-up of Stripping

Paving Layout and Process

The paving was planned to be done in two lifts for both right and left lanes. The paving plan for this section has been shown in Figures P4 and P5. Table 37 shows a summary of the paving plan.

Paving of the lift 1 of 2 on the left lane started at the beginning of ADOT 3 at 2:20 P.M. and was completely placed, although not rolled, to the end of ADOT 5 by 6:25 P.M. The average temperature behind the paver was 271 degrees for ADOT 5. The paver moved at approximately 25 feet per minute so the majority of the time the paver was not moving. Time gaps were generally between test sections and not inside. The overlay thickness was 2.5 inches in ADOT 3 and changed to 2 inches in ADOT 5. The 0.5 inch decrease was obtained gradually over the first 90 feet of the 432 feet milling transition used in this section.

On May 2, 1990, paving of lift 1 of 2 on the right lane in ADOT 5 began before 5:00 P.M. and completed at 6:00 P.M. The temperature behind the paver was 260 degrees throughout the section. Inside the actual SHRP 040509 section, the uncompacted depth was 2.75 inches and the compacted depth was 2 inches.

On May 3 paving of lift 2 of 2 on the left lane on ADOT 5 began at 9:45 A.M. and reached the end of ADOT 5 by 10:40 A.M. The temperature averaged 258 degrees but varied between 250 degrees and 265 degrees. The uncompacted depth was 2.75 inches and the compacted depth ranged between 2 inches and 2.25 inches.

On May 8 paving of the lift 2 of 2 on the right lane was paved. Hot plant sampling of recycled asphalt pavement materials was done on this day. Table 38 shows the summary of paving on ADOT 5 as well as compliance with the density requirements.

TABLE M-5- Measured Depths of Milling in ADOT's Test Section 5

Transverse Location, Feet	Depth of Milling, Inches — Longitudinal Location Along SHRP Test Section, Feet						Average Milled Depth	Pass
	0	100	200	300	400	500		
6	1 3/4	1 3/4	2	1 7/8	2	1 7/8	1 7/8	4D
12	2 1/2	2 3/8	2 1/4	2 1/8	2 3/8	2 3/8	2 1/3	4E
16.5	2 5/8	2 9/16	2 3/8	2 7/16	2 1/4	2 5/8	2 1/2	4C
22	2 3/4	2 7/8	2 7/8	2 3/4	2 5/8	2 3/4	2 3/4	3D
22.5	(2 1/2)	(2 7/16)	(2 11/16)	(2 1/4)	(2)	(2 3/8)	(2 3/8)	4C
28	3	2 3/4	3	3	2 5/8	2 3/4	2 7/8	3D
32	2 3/4	2 3/4	2 7/8	3	3	2 3/4	2 7/8	3C

Numbers in parenthesis are depths of milling with reference to new pavement.
Transverse location is reported in feet, measured from right edge of the east bound roadway.

TABLE 37- SUMMARY OF PAVING PLAN FOR ADOT 5

Lane	Date	Day	Lift
RIGHT	05/02/90	4	1/2
	05/08/90	7	2/2
LEFT	05/01/90	3	1/2
	05/03/90	5	2/2

Sampling

On May 8, recycled materials were sampled off the plant. The samples consist of:

(2) 55 gallon drums coarse and fine Recycled Asphalt Pavement (RAP) material after blended. This was obtained by running the drum dryer plant in the morning without the asphalt concrete or mineral admixture. Materials were transported from bins to silo as usual except no other material added. The sample was actually collected from a chute on side of silo directly into barrels (Sent to SHRP).

(1) 5 gallon buckets of the same Recycled Asphalt Pavement (RAP) material described above (Currently at the ATRC).

(2) 55 gallon drums of blended mineral aggregate used in the recycle mix. This was obtained from the splitter just prior to the aggregate feed into the hot drum. The cement feed was claimed to have been shut off prior to dropping this sample to the splitter (Sent to SHRP).

(11) 5 gallon buckets of AC-20 taken from valve off of drum feeder hose (Sent to SHRP).

(1) 5 gallon portland cement taken off the belt below cement silo. Cement was delivered to site once a day (Currently at the ATRC).

(3) 5 gallon buckets full of recycle mix were obtained off the grade. These were taken later in the day. (One of these was used by the ADOT project personnel for compliance testing, one was sent to SHRP along with the above samples, and the other one is currently at the ATRC).

TABLE 38- SUMMARY OF PAVING ON ADOT 5

Lane	Lift	SHRP Tonnage	Compacted Depth (in)	Gage/Point/Density (pcf)	P_T (%)
Right	1/2	294	2 1/4-2 5/8	1/A/139.7	100
	2/2	277	2 3/8	1/A/139.1	87
Left	1/2	-	≈ 2	-	-
	2/2	-	2 3/8	1/A/141.1	100

Notes: 1. Gage: 1: Troxler Troxler 4640B (Thin Lift)

2. Points: A: 3', 6'& 9'transverse @100' interval, 18 points

CONSTRUCTION OF TEST SECTION 6 (ADOT 6 & SHRP 040502)

The ADOT 6 was milled and paved during days 3, 4, 5, 6, and 7 of the 17-day work on SHRP test sections. The work consisted of milling two lanes of the existing pavement and paving with recycled asphalt concrete in one lift. The overlay thickness was 2.0 inches with average 1.0 inch milling.

Milling Layout and Process

The milling sequence is shown in Figure M2 and the milling depths are shown in Table M6. The pass sequence in Table M6 refers to milling sequence in Figure M2. Table 39 shows the mill depths for the two lanes and corresponding dates of milling.

The milling began on the left lane on May 1. On the next day, the right lane was milled. The milling was inadequate because the asphalt concrete friction course (ACFC) was still visible (Photo 37). The remilling was requested by the ATRC and was done on May 4. On that day the right lane was remilled. The re-milling sequence has been illustrated in Figure M3. The first pass of the milling machine was the left pass of the right lane. The average depth of the right edge of this pass with reference to the previous elevation was 1 inch. This would put the middle of the right lane at a depth of approximately 1.25 inch to 1.5 inch. After completing the left pass of sections ADOT 6, 8, and 10, the milling machine started remilling of the right pass of ADOT 6. On the right pass it appeared that though the miller setup was such that the depths at the middle of the two passes matched up, the depth on the right edge was essentially flush with the shoulder. This would mean the miller was milling on a slope and not getting any new depth in the right wheel path. Finally on May 8, the final milling of ADOT 6 was completed. The right edge at the shoulder stripe had a vertical edge after this mill pass was complete. The average depth was 3/4 inch on this right edge and ranged from 1/2 inch to 7/8 inch. Photo 38 shows the remilled right lane.

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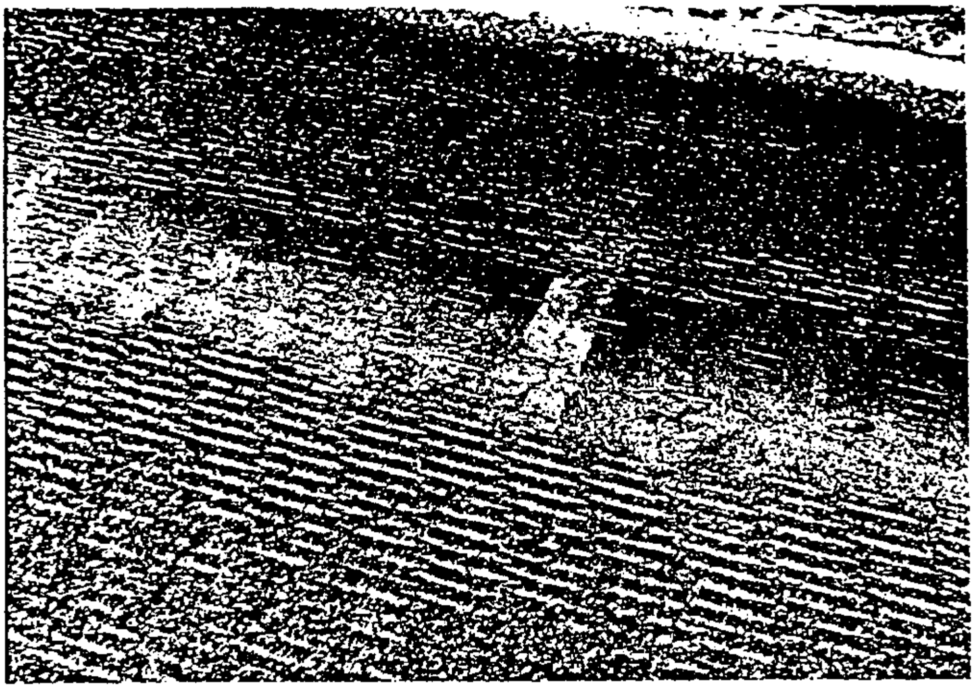

Photo 37- Insufficient Milling on ADOT 6

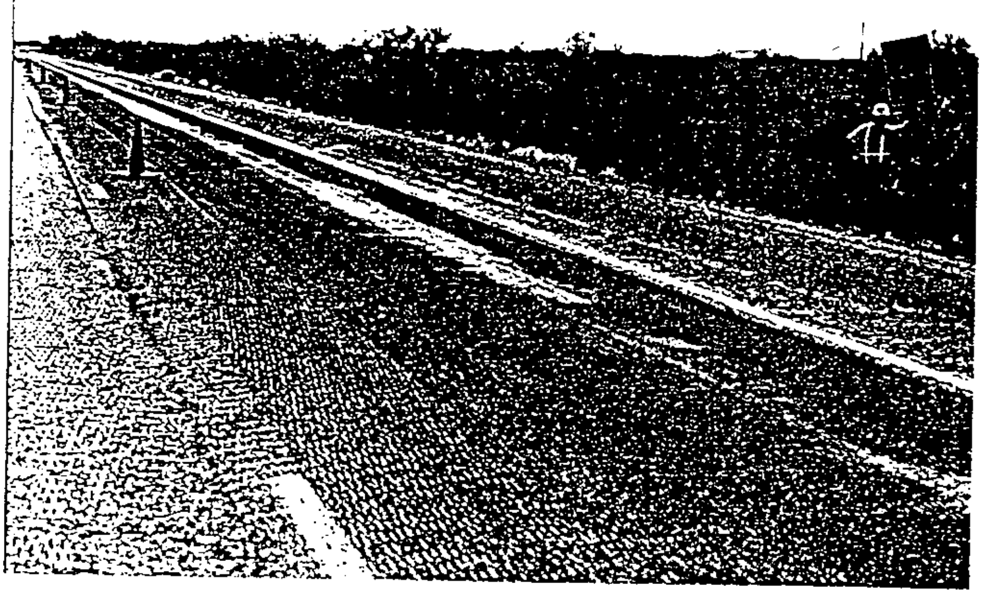

Photo 38- Remilled Right Lane on ADOT 6

TABLE M-6- Measured Depths of Milling in ADOT's Test Section 6

Transverse Location, Feet	Depth of Milling, Inches — Longitudinal Location Along SHRP Test Section, Feet						Average Milled Depth	Pass
	0	100	200	300	400	500		
16.5	5/8	9/16	3/4	1/2	1/2	1/2	9/16	4J
22	1	3/4	1	1	7/8	1	15/16	3G
28	1	7/8	1	7/8	1	1	1	3F

Transverse location is reported in feet, measured from right edge of the east bound roadway.

TABLE 39- RANGE IN MILLING DEPTHS FOR ADOT 6 FOR DIFFERENT LANES

Lane	Date	Day	Range of Depth (in)
LEFT	5/01/90	3	3/4 - 1 1/8
RIGHT	5/02, 5/04, 5/08	4, 6 & 7	1/2 - 7/8

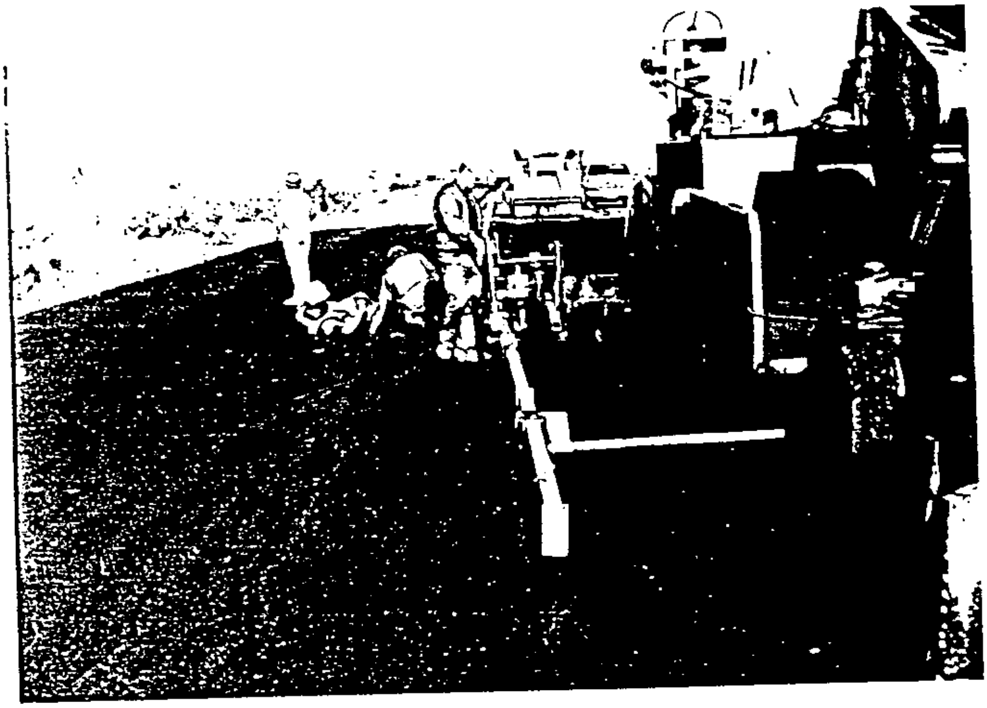

Photo 39- Right Lane Paving on ADOT 6

Photo 40- Right Lane Paving on ADOT 6

TABLE 41- SUMMARY OF PAVING ON ADOT 6

Lane	Lift	SHRP Tonnage	Compacted Depth (in)	Gage/Point/Density (pcf)	P_T (%)
Right	1/1	234	2 1/2	1/A/139.9	93
Left	1/1	181	2.0 - 2 1/2	1/A/140.7	100

Notes: 1. Gage: 1: Troxler Troxler 4640B (Thin Lift)

2. Points: A: 3', 6'& 9'transverse @100' interval, 18 points

CONSTRUCTION OF TEST SECTION 7 (ADOT 7 & SHRP 040506)

The ADOT 7 was milled and paved during days 8, 9, 14, and 16 of the 17-day work on SHRP test sections. The work consisted of milling two lanes of the existing pavement and paving with end-product (virgin) asphalt concrete in two lifts. The overlay thickness was 2.0 inches with average over 2.0 inches milling.

Milling Layout and Process

The milling sequence is shown in Figure M1 and the milling depths are shown in Table M7. The pass sequence in Table M7 refers to milling sequence in Figure M1. Table 42 shows the mill depths for the two lanes and corresponding dates of milling.

The milling began on the right lane on May 16. This was an intensive surface preparation section. The depth of milling was slightly more than 2 inches in most of the cases. On the next day, the left lane was milled.

TABLE M-7- Measured Depths of Milling in ADOT's Test Section 7

Transverse Location, Feet	Depth of Milling, Inches — Longitudinal Location Along SHRP Test Section, Feet						Average Milled Depth	Pass Sequence
	0	100	200	300	400	500		
5	2 1/2	2 1/2	2 1/2	2 3/4	2 1/2	2 1/2	2 1/2	8L
9	3	2 3/4	2 3/4	2 7/8	2 7/8	2 7/8	2 7/8	8K
15	3 1/4	3 1/8	3 1/8	3 1/8	3	3 1/8	3 1/8	8J
21	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4	2 7/8	2 3/4	8J
21	(2 7/8)	(2 1/8)	(2 1/2)	(2 1/2)	(2)	(2 1/2)	(2 3/8)	9B
27	2 7/8	2 3/4	3 1/8	3	2 7/8	2 3/4	2 7/8	9B
32	2 3/4	3 1/8	3	2 3/4	2 7/8	2 3/4	2 7/8	9A
38	2	1 1/2	1 1/8	1 1/2	1 1/8	1 1/4	1 3/8	9A

Numbers in parenthesis are depths of milling with reference to new pavement.
Transverse location is reported in feet, measured from right edge of the east bound roadway.

TABLE 42- MILLING DEPTHS FOR ADOT 7 FOR DIFFERENT LANES

Lane	Date	Day	Range of Depth (in)
RIGHT	5/16/90	8	2 3/4 - 3 1/4
LEFT	5/17/90	9	2 3/4 - 3 1/8

Paving Layout and Process

The paving was planned to be done in two lifts with end-product asphalt concrete for both right and left lanes. The paving plan for this section has been shown in Figures P1 and P3. Table 43 shows a summary of the paving plan.

TABLE 43- SUMMARY OF PAVING PLAN FOR ADOT 7

Lane	Date	Day	Lift
RIGHT	05/16/90	8	1/2
	05/24/90	14	2/2
LEFT	05/17/90	9	1/2
	06/04/90	16	2/2

On May 16, lift 1 of 2 on the right lane was paved between 3:30 P.M. and 5:00 P.M. The temperature behind the paver was 221 degrees at the beginning and ranged from 240 degrees and 250 degrees throughout the majority of the section. The uncompacted depth was 2-3/4 inches to 2-7/8 inches and the compacted depth ranged between 2-3/8 inches and 2-1/2 inches. On May 17, lift 1 of 2 of the left lane was paved. Paving began at 12:30 P.M. and was completed by 1:45 P.M.. The temperature at the beginning of the SHRP 040506 section was 213 degrees, 230 degrees in the middle, and down to 208 degrees by the end. At local station 4+50 the temperature was 190 degrees before the first pass of the roller. The material was laid at a depth of 2-5/8 inches to 2.75 inches and compacted to depths of 2-3/8 inches to 2.5 inches.

On May 24, paving on lift 2 of 2 on the right lane of ADOT 7 was started. Some difficulties were faced while paving this section. The first 50 feet of the section was paved before it was determined that the mat was too shallow. Contractor removed material behind paver in wheel path and backed up to beginning. The first 50 feet was repaved and again, it was too shallow. The same removal was done and the first 50 feet was paved for the third time. This time the mat was deep enough and paving continued. The summary data for paving does not include any of the data from the first two attempts. The paving began at 5:40 P.M. and ended at 6:15 P.M.. The windrow temperature was on the order of 225 degrees. The mat temperature behind the paver was between 220 degrees and 231 degrees. The uncompacted depth ranged between 2-1/4 inches and 2-5/8 inches and compacted ranged between 1-3/4 inches and 1-7/8 inches. Paver stops were frequent due to slow delivery of material. Paver stops made 0.5 inches to 1 inches transverse humps that were not visible after rolling. Stops were recorded at local stations 0+15, 0+42, and 4+02.

On June 4, the final lift of on the left lane of ADOT 7 was completed. This had been missed on a previous date, and due to Contractor scheduling, was not completed until this day. The contractor was completing end product paving on a part of the original reconstruction project west of the SHRP test sections near the truck stop at Hidden Valley T.I. June 1, the hot plant was switched back to End Product. The production of that day was 4201 tons satisfying the 4000 ton requirement prior to reaching SHRP sections on the next work day (06/04/90).

On June 4, paving of lift 2 of 2 on the left lane of ADOT 7 began at 4:45 P.M. and ended at 5:15 P.M. The temperature behind the paver was 222 degrees to 227 degrees. The uncompacted depth was between 2-5/8 inches and 3-3/8 inches. Temperatures had reached between 160 degrees and 173 degrees when the final compaction was done about an hour later. Compacted depths ranged from 2-1/4 inches to 2-3/4 inches. Table 44 shows the summary of paving on ADOT 7 as well as compliance with the density requirements.

TABLE 44- SUMMARY OF PAVING ON ADOT 7

Lane	Lift	SHRP Tonnage	Compacted Depth (in)	Gage/Point/Density (pcf)	P_T (%)
Right	1/2	-	2 3/8-2 1/2	1/A/140.0	100
	2/2	231	1 3/4-1 7/8	1/A/136.2	50
Left	1/2	207	2 3/8-2 1/2	1/A/138.9	97
	2/2	161	2 1/4-2 3/4	4/B/138.9	98

Notes:

1. Gage:
   1: Troxler Troxler 4640B (Thin Lift)
   4: Troxler 3411B (Casa Grande)
2. Points:
   A: 3', 6'& 9'transverse @100' interval, 18 points
   b: 10 random points, 10 points

CONSTRUCTION OF TEST SECTION 8 (ADOT 8 & SHRP 040505)

The ADOT 8 was milled and paved during days 5, 6, 8, 14, and 16 of the 17-day work on SHRP test sections. The work consisted of milling two lanes of the existing pavement and paving with end-product (virgin) asphalt concrete in one lift. The overlay thickness was 2.0 inches with average 1.0 inches milling.

Milling Layout and Process

The milling sequence is shown in Figure M1 and the milling depths are shown in Table M8. The pass sequence in Table M8 refers to milling sequence in Figure M1. Table 45 shows the mill depths for the two lanes and corresponding dates of milling.

The left lane of ADOT 8 was milled on May 3. This was a nominal surface preparation section. The depth of milling was around 1 inch in most of the cases. The milling began on the right lane on May 4. In order to verify that 3/4-inch milling depth originally planned was inadequate to remove ACFC in the badly rutted sections, the ruts in the right wheel path were measured. The measurements were as follows:

Longitudinal Offset	Depth
0	1/2 inches
100	1/2 inches
200	1.0"
300	3/4"
400	1.0"
500	3/4"

After completing the left pass of sections ADOT 6, 8, and 10 the miller backed down the right pass in the same sections. ADOT 8 was inspected and looked satisfactory in the wet condition. On drying, the milling on this section was found unsatisfactory. Photos 41 thru 44 show the milled surface on ADOT 8. The right pass of ADOT 8 would be remilled one more time. On the first right pass it appeared that the miller was milling on a slope and not getting any new depth in the right wheel path. On May 16, the right lane of ADOT 8 was remilled. The remilling sequence has been shown in Figure M3.

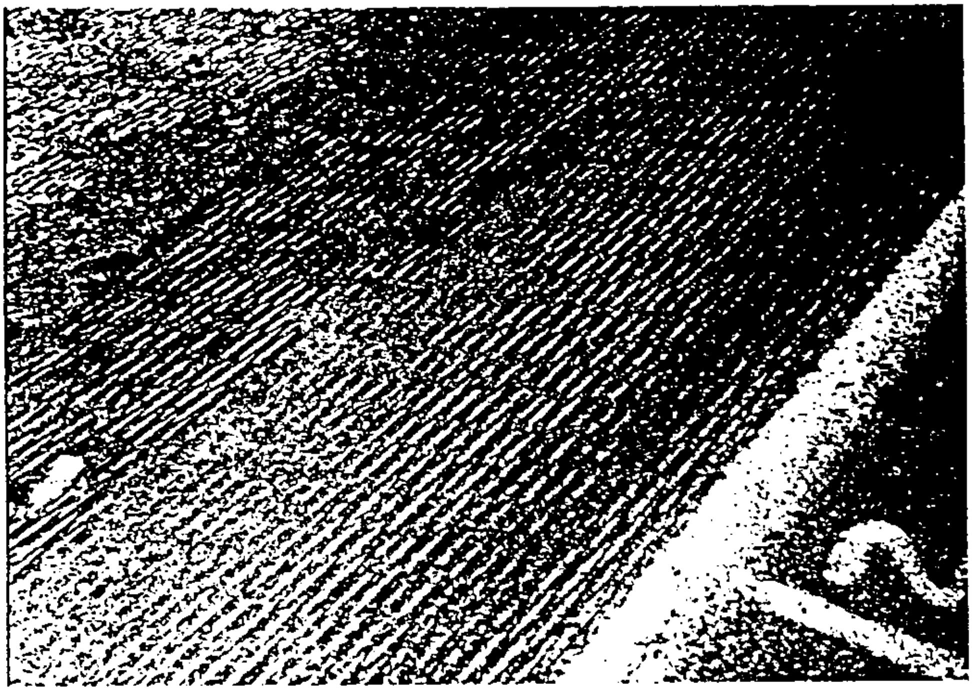

Photo 41- Insufficient Milling on ADOT 8

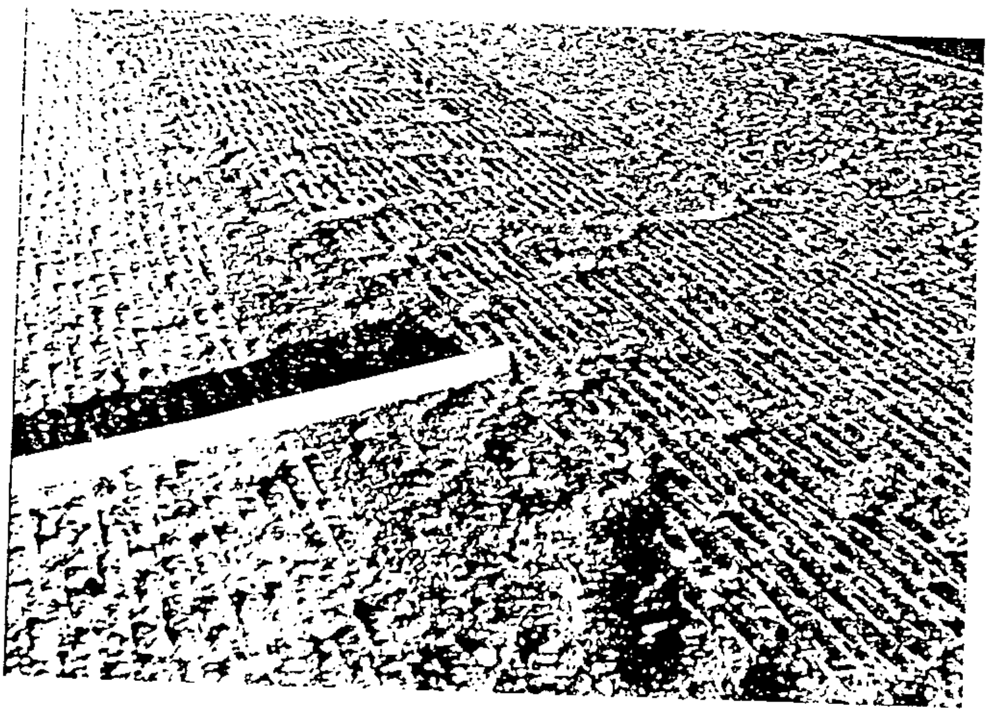

Photo 42- Insufficient Milling on ADOT 8

Photo 43- Milled Surface on ADOT 8

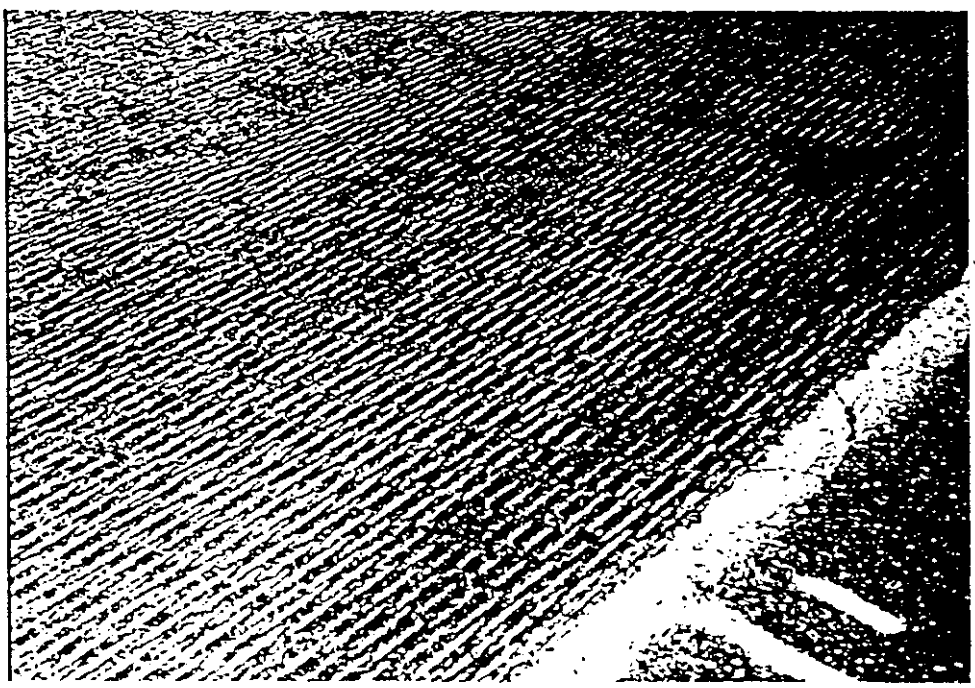

Photo 44- Milled Surface on ADOT 8

TABLE M-8- Measured Depths of Milling in ADOT's Test Section 8

Transverse Location, Feet	Depth of Milling, Inches — Longitudinal Location Along SHRP Test Section, Feet						Average Milled Depth	Pass
	0	100	200	300	400	500		
16	1 1/4	1 1/8	1 1/4	1 1/2	1 1/4	1 1/2	1 3/8	6B

Transverse location is reported in feet, measured from right edge of the east bound roadway.

TABLE 45- RANGE IN MILLING DEPTHS FOR ADOT 8 FOR DIFFERENT LANES

Lane	Date	Day	Range of Depth (in)
RIGHT	5/4/90, 5/16/90	6, 8	1 1/4 - 1 1/2
LEFT	5/3/90	5	3/4

Paving Layout and Process

The paving was planned to be done in one lift of 2.0 inches with end-product asphalt concrete for both right and left lanes. The paving plan for this section has been shown in Figure P3. Table 46 shows a summary of the paving plan.

On May 24 paving of lift 1 of 1 on the right lane started. The paving began at 6:15 P.M. and ended at 7:40 P.M. At 6:40 P.M. the paver had reached local station 4+10 and stopped. This happened because there was not enough material to finish the section, no trucks were waiting to dump, and the hot plant had apparently been shut down. The material quantity had been miscalculated. The hot plant was already in the process of being recalibrated for Asphalt Concrete Friction Course (ACFC) which was scheduled to begin on the next day of work. The contractor was told that if they did not get more material out to the job, the entire 500 feet SHRP section 0405050 would have to be removed and redone because a transverse joint inside the 500 feet section was out of specification. A final load was delivered at 7:30 P.M. and paving continued to the end of the section. The uncompacted depth throughout the section ranged from 2-1/2 inches to 2-7/8 inches. The compacted depth ranged from 1-7/8 inches to 2 inches toward the middle and was 1-5/8 inches at the very end. Paver stops were frequent in this section. They were at local stations 0+26, 0+52, 0+91, 3+32, 3+48, 4+10 @ 6:40 P.M., 4+15 @ 7:20 P.M., 4+20 @ 7:30 P.M., and 4+98.

On June 4 paving of lift 1 of 1 on the left lane of ADOT 8 started. Paving began at 5:00 P.M. and ended at 5:40 P.M.. The temperature behind the paver was 228 degrees to 235 degrees. The uncompacted depth was between 3 inches and 2-1/8 inches. Nearly one hour after the final compaction was done, temperatures reached between 172 degrees and 191 degrees. Compacted depths ranged from 2-7/8 inches to 2-1/8 inches. There was suspicion that the reported uncompacted depths were compacted depths in reality.

Table 47 shows the summary of paving on ADOT 8 as well as compliance with the density requirements.

TABLE 46- SUMMARY OF PAVING PLAN FOR ADOT 8

Lane	Date	Day	Lift
RIGHT	05/24/90	14	1/1
LEFT	06/04/90	16	1/1

TABLE 47- SUMMARY OF PAVING ON ADOT 8

Lane	Lift	SHRP Tonnage	Compacted Depth (in)	Gage/Point/Density (pcf)	P_T (%)
Right	1/1	188	1 5/8-2.0	1/A/137.7	72
Left	1/1	114	2 1/8-2 7/8	4/B/138.9	100

Notes:
1. Gage:
   1: Troxler Troxler 4640B (Thin Lift)
   4: Troxler 3411B (Casa Grande)
2. Points:
   A: 3', 6'& 9'transverse @100' interval, 18 points
   B: 10 random points, 10 points

CONSTRUCTION OF TEST SECTION 9 (ADOT 9 & ADOT 040510)

The ADOT 9 is one of two test sections built by ADOT as additional test sections in SPS-5. The design of this section is a so-called "inverted" design and utilized recycled overlay over virgin mix. The work consisted of deep milling (about 4 inches) of existing pavement, paving the milled trench with virgin asphalt concrete and an overlay of 3 inches of recycled asphalt concrete mix. The ADOT 9 was milled and paved during days 8, 9, and 15 of the 17-day work on SHRP test sections.

Milling Layout and Process

The milling sequence is shown in Figure M1 and the milling depths are shown in Table M9. The pass sequence in Table M9 refers to milling sequence in Figure M1. Table 48 shows the mill depths for the two lanes and corresponding dates of milling.

The milling began on the right lane on May 16.. This was an intensive surface preparation section. The depth of milling was around 4 inches in most of the cases. The existing ACFC was completely milled off. The thickness of ACFC layer was 1 inch to 1-1/4 inch.

The trench for ADOT 9 ends 168 feet west of the canal bridge structure. At this point the miller lifted up from the 4-inch depth and began toward the bridge, tapering from 0 inch down to 3 inches at the bridge approach slab. The reason for this was that the ADOT 9 trench would be paved with End product material up to the end of the 4-inch portion and left for several days until paving a second left with recycled asphalt concrete. In the meantime, a temporary ramp, paved on roofing paper, was constructed over the last twenty feet approaching the bridge so that the traffic did not experience a high bump. Photos 45 and 46 show this temporary paving.

On May 17, the left lane of ADOT 9 was milled. The milling matched the production on the previous day. The miller moved at a rate of 50 feet per minute which is typical of the speed throughout the project. The tack truck applied tack at a rate of 0.1 gallons per square yard and the truck moved at a rate of 14 feet per second.

DRAFT

TABLE M-9 Measured Depths of Milling in ADOT's Test Section 9.

Transverse Location, Feet	Depth of Milling, Inches — Longitudinal Location Along SHRP Test Section, Feet: 0	100	200	300	400	500	Average Milled Depth	Pass
0	3 7/8	4 3/8	4 3/8	4	4 1/8	4 1/8	4 1/8	8P
6	4 5/8	4	4	4	4	5	4 1/4	8P
9	4	3 1/2	4 1/8	3 7/8	3 3/4	3 3/4	3 7/8	8Q
15	4 1/4	3 3/4	4	4 1/8	4 1/2	4 1/8	4 1/8	8O
21	3 7/8	4	4	4	4	3 7/8	4	8O
21	(4 1/4)	(4)	(4 1/8)	(4 1/8)	(4)	(3 7/8)	(4 1/8)	9E
26	3 1/2	4	4 1/4	4	4	4 1/8	4	9E
32	4 1/8	3 7/8	4 1/8	4 1/4	4 1/8	4	4 1/8	9D
38	-	-	-	4 1/2	3 3/4	3 3/4	4	9D

Numbers in parenthesis are depths of milling with reference to new pavement.
Transverse location is reported in feet, measured from right edge of the east bound roadway.

TABLE 48- MILLING DEPTHS FOR ADOT 9 FOR DIFFERENT LANES

Lane	Date	Day	Range of Depth (in)
RIGHT	5/16/90	8	2 3/8 - 3.0
LEFT	5/17/90	9	3 1/2 - 4 1/8

Paving in ADOT 9 extended beyond the limits of the underlying End Product material into the transition area where milling increased depth gradually until reaching a depth of 3 inches at the bridge approach slab. The milling was completed in this way so that the recycle lift in ADOT 9 could be laid at constant depth and still meet flush with the approach slab. Prior to paving to the bridge, the temporary ramp just prior to the approach slab was removed with a loader.

Table 50 shows the summary of paving on ADOT 9 as well as compliance with the density requirements.

TABLE 50- SUMMARY OF PAVING ON ADOT 9

Lane	Lift	SHRP Tonnage	Compacted Depth (in)	Gage/Point/Density (pcf)	P_T (%)
Right	1/2	302*	3 1/2-4 1/4	1/A/140.4	91
	2/2	277**	2 7/8-3.0	4/B/143.0	100
Left	1/2	283*	4.0-4 3/8	1/A/138.2	97
	2/2	188**	3.0-3 1/4	-	-

*virgin asphalt concrete

**recycled asphalt concrete

Notes: 1. Gage: 1: Troxler Troxler 4640B (Thin Lift)
4: Troxler 3411B (Casa Grande)

2. Points: A: 3', 6'& 9'transverse @100' interval, 18 points
B: 10 random points, 10 points

CONSTRUCTION OF TEST SECTION 10 (ADOT 10 & SHRP 040511)

ADOT 10 is the second test section of ADOT's own experiment in SPS-5. This section employs a 2-inch overlay of Asphalt Rubber Asphalt Concrete (AR-AC). The ADOT 10 was milled and paved during days 5, 6, 10, and 17 of the 17-day work on SHRP test sections. The work consisted of milling the existing asphalt concrete friction course and paving with Asphalt Rubber Asphalt Concrete (AR-AC) in one lift. The overlay thickness was 2.0 inches with average 1.0 inch milling.

Milling Layout and Process

The milling sequence is shown in Figure M1 and the milling depths are shown in Table M10. The pass sequence in Table M10 refers to milling sequence in Figure M1. Table 51 shows the mill depths for the two lanes and corresponding dates of milling.

The left lane of ADOT 8 was milled on May 3. This was a nominal surface preparation section. The depth of milling was around 1 inch in most of the cases. The milling began on the right lane on May 4. In order to verify that 0.75 inch milling depth originally planned was inadequate to remove ACFC in the badly rutted sections, the ruts in the right wheel path were measured. The measurements were as follows:

Longitudinal offset (ft)	Depth
0	1.0 inches
100	3/4 inches
200	7/8 inches
300	3/4 inches
400	3/4 inches
500	1/2 inches

After completing the left pass of sections ADOT 6, 8, and 10 the miller backed down the right pass in the same sections. ADOT 10 was inspected and appeared to be properly milled. This section was still wet. Later when the surface dried up deficiency in milling was found. The right pass of ADOT 10 was remilled. It appeared that on the right pass, the miller was milling on a slope and was not getting any depth on the right wheel path. On May 18, the right lane was remilled. The remilling sequence has been shown in Figure M3. Photos 47 thru 50 show the milled surface.

TABLE M-10- Measured Depths of Milling in ADOT's Test Section 10.

Transverse Location, Feet	Depth of Milling, Inches — Longitudinal Location Along SHRP Test Section, Feet							Average Milled	Pass Depth
	0	100	200	300	400	500	600		
16	1 1/8	1 1/4	1 1/4	1 3/8	1 1/16	1 1/8	1	1 1/8	6C
22	1	1	7/8	1	1 1/8	3/4	7/8	1	5D

Transverse location is reported in feet, measured from right edge of the east bound roadway.

TABLE 51- RANGE IN MILLING DEPTHS FOR ADOT 10 FOR DIFFERENT LANES

Lane	Date	Day	Range of Depth (in)
RIGHT	5/4/90, 5/18/90	6, 10	3/4 - 1 1/2
LEFT	5/08/90	5	≈3/4

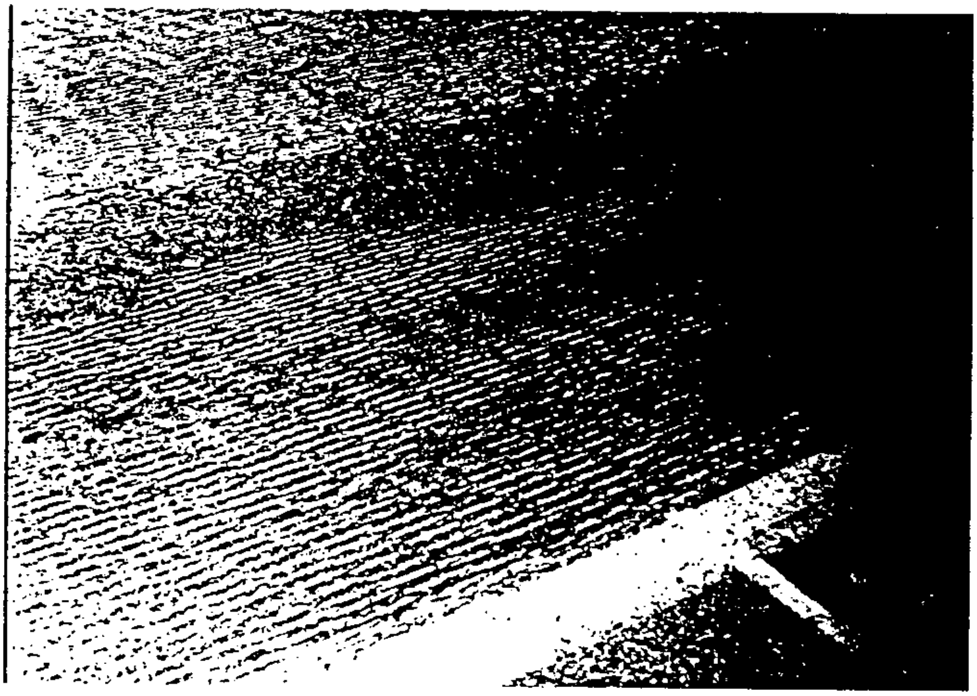

Photo 47- Insufficient Milling on ADOT 10

Photo 48- Insufficient Milling on ADOT 10

Photo 49- Milled Surface of ADOT 10

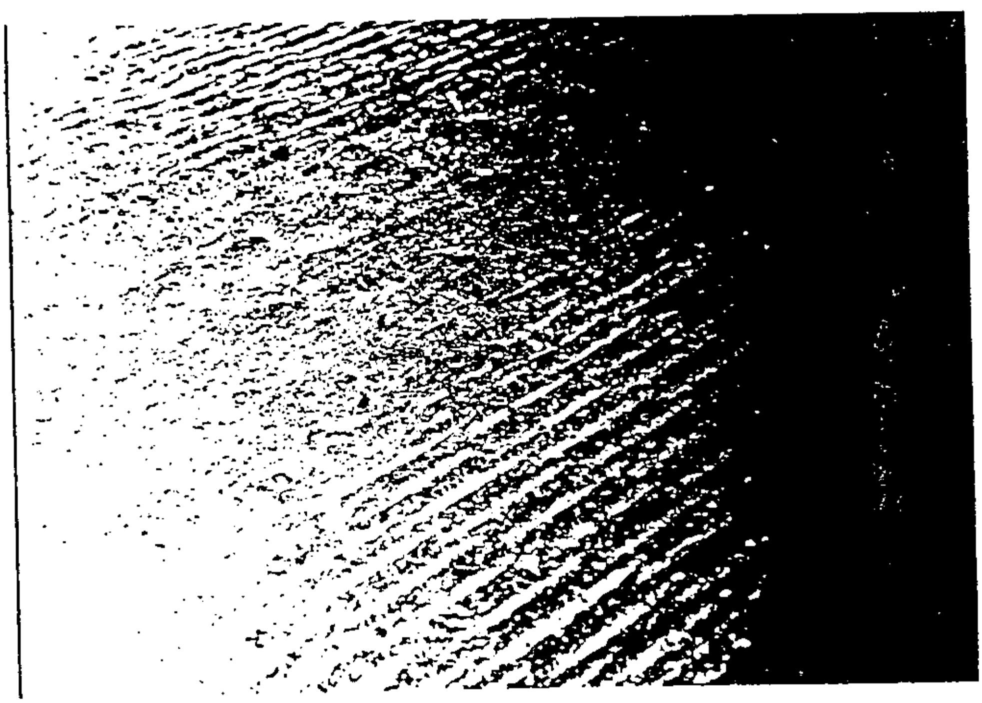

Photo 50- Milled Surface on ADOT 10

Paving Layout and Process

The paving was planned to be done in one lift with asphalt rubber concrete for both right and left lanes. The paving plan for this section has been shown in Figure P6. Table 52 shows a summary of the paving plan.

TABLE 52- SUMMARY OF PAVING PLAN FOR ADOT 10

Lane	Date	Day	Lift
RIGHT	06/13/90	17	1/1
LEFT	06/13/90	17	1/1

On June 13 paving of ADOT 10 started. Two batches of asphalt rubber were mixed. Table 53 give the weight-volume conversions of the materials mixed.

TABLE 53- WEIGHT-VOLUME CONVERSION OF ASPHALT RUBBER MATERIALS

BATCH NO.	MIX TEMP	AC-10 VOLUME @ MIX TEMP (gal)	AC-10 VOLUME @ 60 ^{O}F (gal)	AC-10 WEIGHT (lbs)	WEIGHT RUBBER (lbs)	PERCENT RUBBER
1	360^{O}F	2900	2608	22195	5400 (108 bags)	24.3 %
2	375^{O}F	2850	2549	21694	4300 (86 bags)	19.8 %

BATCH NO.	AC TEMP	AC-10 VOLUME @ MIX TEMP (gal)	AC-10 VOLUME @ 60 ^{O}F (gal)	AC-10 WEIGHT (lbs)	WEIGHT RUBBER (lbs)	PERCENT RUBBER
1	450^{O}F	2900	2524	21480	5400 (108 bags)	25.1 %
2	450^{O}F	2850	2481	21115	4300 (86 bags)	20.4 %

Photos 51 and 52 show the mixing process. Photos 53 and 54 show the boot truck and the tonnage indicator.

The volume of AC used was read off of the gage on the mixer. The calculated percentage of rubber is dependent upon where that gage is measuring the volume of AC delivered. The rubber weight was simply determined from the bag count and the fact that each bag weighed 50 pounds.

Both loads of mixed asphalt rubber were weighed on the scale at the hot plant with the following results. The boot truck when full of Load 1 material weighed 57,500 pounds and 29,720 pounds after unloading into larger tank. Load 2 weighed 56,100 pounds when full of Load 2 material and was not weighed after unloading. It must be assumed that the boot truck had the same amount of material left over after unloading. If that was the case, the same tare weight was applicable.

Haake viscosities were determined with a Haake viscometer by Rick Laveen of International Surfacing Inc. Photo 55 shows a Haake viscometer. Load 1 had a viscosity of 4000 cps at 350^{O}F after an approximate reaction time of 1 hour. A second reading of 5000 cps was taken at 347^{O}F after an approximate reaction time of 1 hour and 10 minutes.

Load 2 was hotter and had a viscosity of 2000 cps at 376^{O}F after an approximate reaction time of 1 hour. A second reading of 3800 cps was taken at 340^{O}F after waiting an additional 15 minutes for the material to cool. It was intended to get the viscosity at 350^{O}F; however, the material cooled on the outside of the one-gallon sample cans first and when the temperature in the middle of the can reads 360^{O}F, the temperature after mixing the sample and bringing in the side material may drop considerably below the target of 350^{O}F. Thus the target temperature was not achieved. A second one-gallon can which sat for a half hour was tested when the temperature reached 350^{O} with a reading of 4000 cps. This sample obviously had much more viscous material at the edges and bottom of the can and could not be considered representative of the material as it was delivered first.

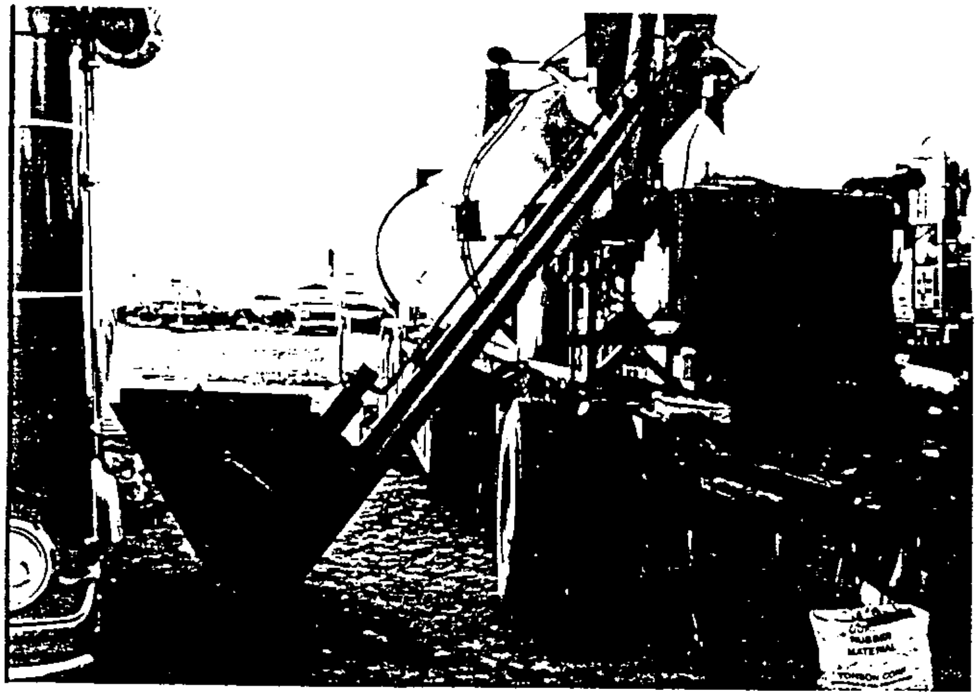

Photo 51- Hooper for Loading Rubber

Photo 52- Rubber Loading into Boot Truck

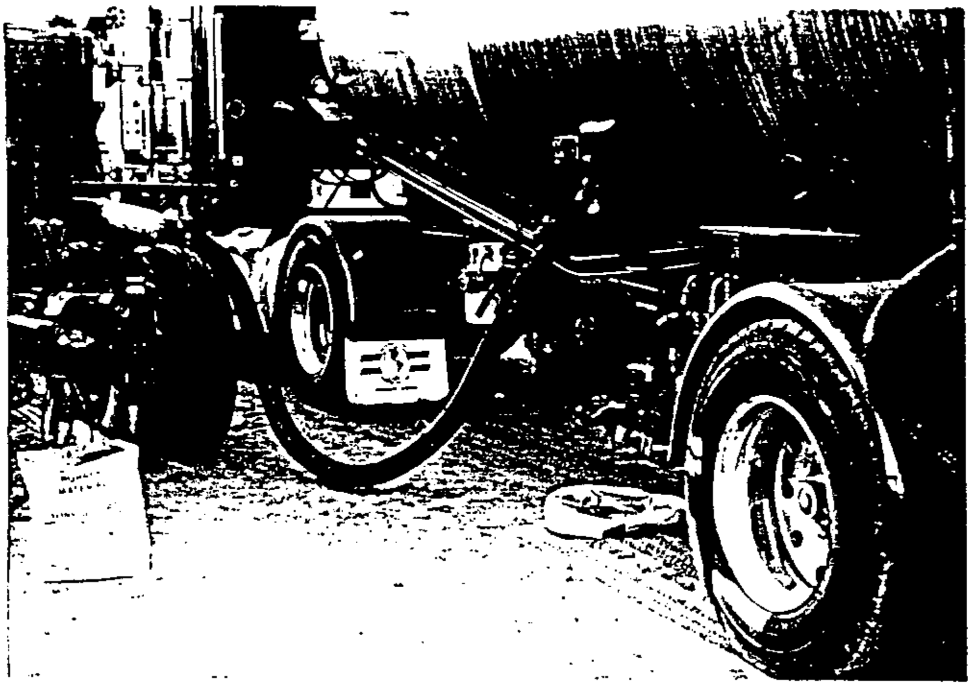

Photo 53- Boot Truck

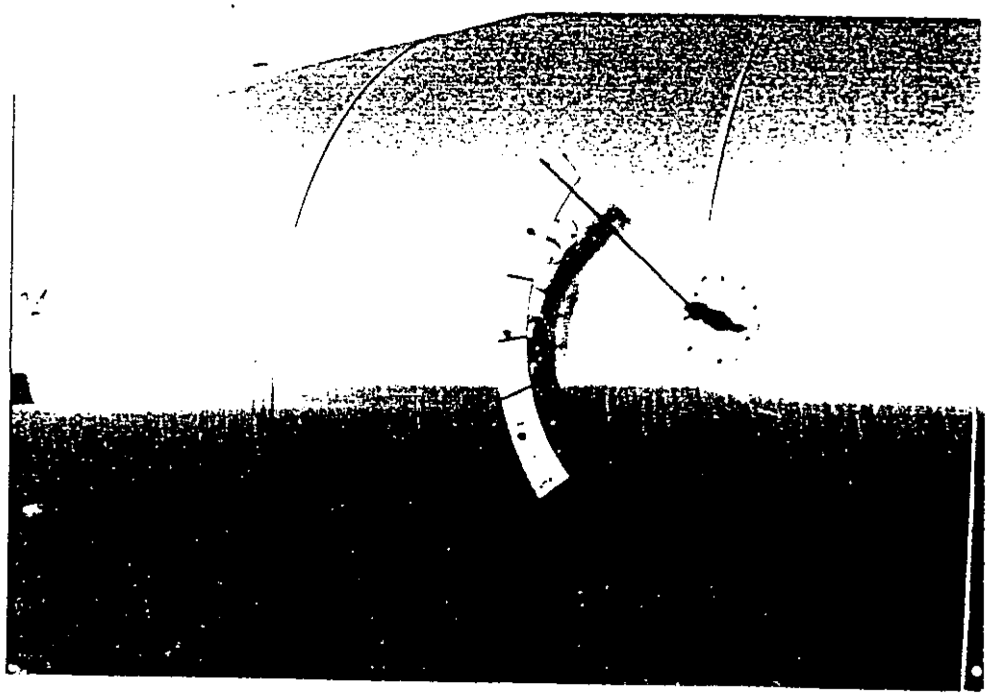

Photo 54- Tonnage Indicator on Boot Truck

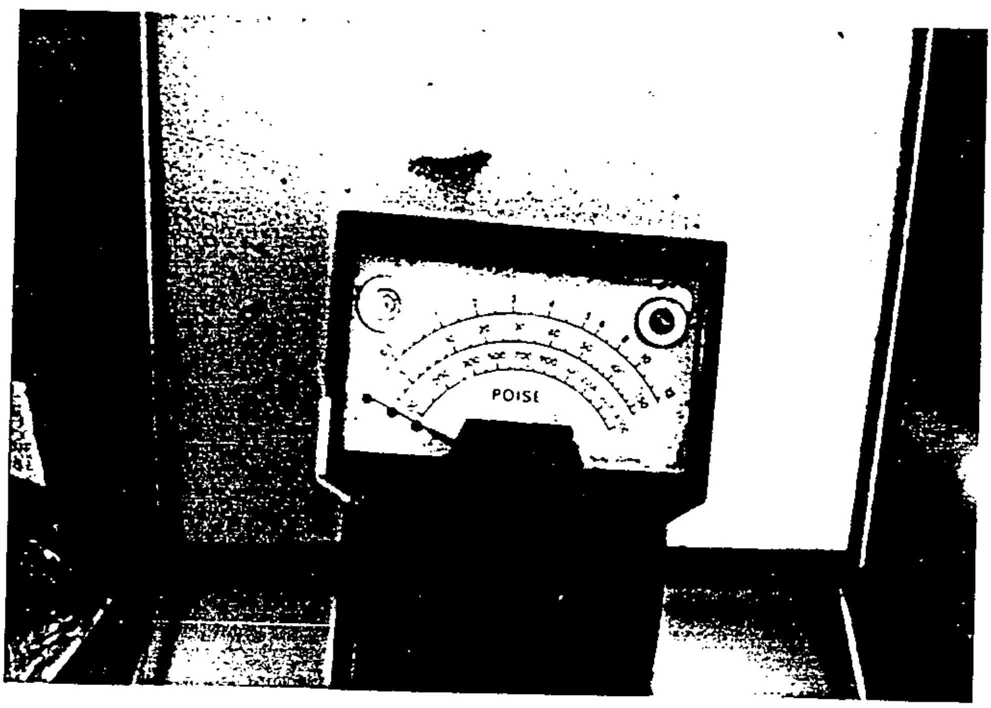

Photo 55- Haake Viscometer

A chronological description of the asphalt rubber mixing process is as follows:

3:00 A.M. Started mixing Load 1.

4:00 A.M. Boot truck full of approximately 2900 gallons of asphalt rubber.

4:50 A.M. Haake viscosities taken.

4:55 A.M. Two 1-gallon asphalt rubber samples pulled out for SHRP (Both samples are with ATRC).

5:00 A.M. Boot truck weighed.

5:10 A.M. Boot truck contents pumped into large second tank.

--- Boot truck weighed.

5:30 A.M. Started mixing Load 2.

6:00 A.M. Boot truck full of approximately 2850 gallons of asphalt rubber.

------ Another boot truck filled up with AC-30 tack. Rubber truck waits for that truck to move out of way.

------ Boot truck weighed.

7:00 A.M. Boot truck contents pumped into large second tank.

------ Tack truck on way to project.

------ Aggregate samples obtained from splitter. Cement in sample. One full splitter trough full wsa transferred into 3 five-gallon buckets. Third bucket contained most of the fines left in bottom of trough (All three are with ATRC).

7:30 A.M. Asphalt rubber binder first mixed with aggregate.

8:50 A.M. First truck drops material in windrow.

The paving on the right lane began at 9:00 A.M. and ended at 9:20 A.M. Photo 56 shows the paving operation. The temperature behind the paver ranged from 255 degrees to 277 degrees. Photo 57 shows the temperature measurement operation.

Photo 56- Asphalt Rubber Asphalt Concrete Paving

Photo 57- Temperature Measurement Operation

The uncompacted depth ranged from 2-1/4 inches to 2-5/8 inches. Compacted depth ranged between 1-7/8 inches and 2-1/4 inches after 3 passes of the rollers. Rolling was much more organized than all other days. Three rollers were used and were staggered so that the full width of pavement was compacted at the same time. Nuclear density readings were taken after each pass of the roller. The rolling continued in double vibratory mode until the density reading stopped increasing. Then static rolling was done. The final rolling on the right lane consisted of 9 passes double vibratory and 3 passes static.

Paving on the left lane began at 4:50 P.M. and was completed by 5:30 P.M. The temperature behind the paver was 270 degrees to 274 degrees. The uncompacted depth was 2.25 inches.

Rolling was commenced faster on this section. Rollers were right behind the paver. The same procedure for determining the adequacy of rolling was employed. This section required 10 double vibratory passes and 2 static passes. The total rolling time from start to end was 1 and a half hours. The temperature at the end of rolling was around 185 degrees.

Paving at the beginning and end of ADOT 10 was full width as shown in Figure P6. This was because the beginning of ADOT is at the east end of the bridge and the road was milled way down to 2 inches near the departure slab and down to 2 inches near the very end of the section because paving had to match flush with the existing roadway surface outside the job.

Nuclear density readings were obtained for the rubber section along with cores for correlation. The results indicated very low compliance but the results were suspect. The cores showed a much higher compliance than the nuclear reading. The core results must be considered the more accurate of the two methods. Table 54 shows the summary of paving on ADOT 10.

TABLE 54- SUMMARY OF PAVING ON ADOT 10

Lane	Lift	SHRP Tonnage	Compacted Depth (in)	Gage/Point/Density (pcf)	P_T** (%)
Right	1/1	146*	2.0 - 23/8	4/B/132.9	18
Left	1/1	180*	2 1/4	4/B/132.2	16

*asphalt rubber asphalt concrete

** No end-product specification. Calculation done in the same way as for test sections 1-9.

Notes: 1. Gage: 4: Troxler 3411B (Casa Grande)

2. Points: B: 10 random points, 10 points

SAMPLING

Samples obtained from ADOT 10 were:

(3) 5 gallon buckets of aggregate taken at the plant from the splitter. These do have the cement in them. (Currently at the ATRC).

(1) 50 pound bag of granulated rubber. (Currently at the ATRC).

(4) 1-gallon buckets of reacted asphalt rubber binder material. (One of these was sent to WTI for testing and the other three gallons of material currently are at the ATRC).

The AC-10 material was not sampled by the ATRC. One gallon was sampled by the project and sent to Central Materials for testing.

PROBLEMS ENCOUNTERED IN ASPHALT RUBBER MIX DESIGN

The development of mix design for asphalt rubber was slow. On June 6, the stability obtained by ADOT Materials Testing section for the asphalt rubber asphalt concrete material was 800 lbs. According to ADOT Materials Test Engineer, a typical asphalt rubber mix should have stability around 1400 lbs-2000 lbs. The ADOT lab was doing test mixes to see if cement could raise the stability to an acceptable number. There was also concern about paving full width in the asphalt rubber test section due to all of the milling that had been done. There was a 1.5 inches lip at the right shoulder and the proposed lift thickness was to be 2 inches. This would have made the material on the shoulder too thin as far as Materials section was concerned. By the end of this day, ADOT Materials Testing had obtained a mix design where the stability was up to 1100 lbs which had 2% cement and 7.9% binder. ADOT Materials Test Engineer recommended at that time to use this mix design and not to pave full width and to only pave with a 1.5 inch mat thickness. Before paving started on the next Thursday, ATRC personnel expressed the opinion that these concessions would compromise the test section and that the ATRC would rather not lose this section yet. It was decided that the contractor would not be allowed to pave as planned. The contractor opted to pave the following Wednesday, June 13. A meeting was set up for June 12. On June 12 a meeting between ADOT project personnel, ATRC representatives, contractor and the subcontractor (International Surfacing, Inc.) was held in the contractors office. A new mix design for rubber was obtained and the plan was set. The rubber section would be paved 2 inches thick and would not be paved full width. Full width would have been acceptable if the rumble rock on the shoulder could have been removed. This was attempted unsuccessfully on June 12, 1990 after the meeting. However, the paving commenced on the next day, June 13. No other problem was encountered during paving.

COST ANALYSIS

The analysis of initial construction cost of SHRP test sections was done in order to get an idea of initial construction costs of different rehabilitation strategies applied in SPS-5 experiment. Both contractor's bid price and state estimates were used in the analysis. The cost consisted of cost of materials (bituminous binder and mineral admixture) and paving cost (asphalt concrete or asphalt rubber asphalt concrete). It is to be noted that cost of aggregates is included in the cost for asphalt concrete. The milling and tacking costs were left out of the analysis because they were similar for all the test sections. In ADOT bid pricing, the milling is paid per square yard. There are two categories of milling cost depending on the depth of milling. ADOT pays $0.30-$0.40 for milling 1/2 inch whereas for milling 1 inch to 3 inches the payment varies from $0.65 to $0.80. Since all SHRP sections for SPS-5 had more than or equal to 1 inch of milling, the cost of milling was essentially similar for all sections. The cost of milling for a 500 feet by 12 feet SHRP test section was about $467.0. The tacking cost is usually paid based on the amount of materials used in tons. A constant rate of 0.1 gallon per square yard of SS1h emulsion was used on all the sections. Since the sizes of all test sections were equal (except ADOT 9 which is 600 feet), tacking cost was also left out in the analysis. The cost of tacking on a 500 feet by 12 feet section was about $67.0.

It is important to note that the bid costs used in the analysis represent the cost required for the items corresponding to this project only and do not necessarily are the actual costs. However, the state estimates can be used as average cost of the items mentioned. The state estimates are based on the historical data about similar types of construction whereas the contractor bid costs reflect a "manipulation" where some bid items are lower or higher that actual costs. Table 55 shows the summary of cumulative cost of materials and paving from the state estimate as well as those paid to the contractor for different test sections. The results do not include the mobilization, milling and tacking cost. However, they include the asphalt plant set up cost as included in the cost of asphalt concrete. Appendix H includes the cost analysis results done item by item.

TABLE 55- ACTUAL AND ESTIMATED COST OF CONSTRUCTION OF TEST SECTIONS

Test Section	Left Lane		Right Lane	
	As-built Cost	State Estimate	As-built Cost	State Estimate
040507	15,410	16,012	17,333	18,037
040504	7,524	7,818	8,457	8,788
040503	6,127 (partial)	5,779 (partial)	14,722	13,884
040508	3,856 (partial)	3,637 (partial)	13,660	12,833
040509	3,775(partial)	3,560 (partial)	9,330	8,799
040502	2,958	2,789	3,824	3,606
040506	5,467	5,680	No	Data
040505	2,171	2,256	3,581	3,720
040510	4,747	4,747	9,567	9,567
040511	16,888	11,266	13,698	9,188

From the analysis it is evident that the thick overlays and the asphalt rubber asphalt concrete sections were the most expensive strategies. The costs of all strategies except the asphalt rubber are comparable with the state estimates. The cost of asphalt rubber asphalt concrete section is especially to be noted. The cost of this section is 50 percent higher than the state estimate. This happened because of the contractor's higher bid price on asphalt rubber and asphalt rubber asphalt concrete.

CONCLUSIONS

The SPS-5 test sections were constructed successfully. However, the following important conclusions can be drawn from this construction project:

1) Low stability was experienced in asphalt rubber asphalt concrete mix design. A mix with stability value of 1100 lbs was used in construction. The mix contained 7.0 percent rubber modified asphalt and 2 percent Type II Portland cement as mineral admixture.
2) In the test sections with minimum restoration strategy, only the asphalt concrete friction course (ACFC) was planned to be milled off. Though the as-built thickness of ACFC layer was 1/2 inch, the milling depth was as high as 1 inch to remove this layer. This happened due to non-uniform ACFC layer and rutting on existing pavement. On ADOT 8 and 10, rut depths varied from 1/2 inch to 1 inch.
3) Differential milling depth was obtained due to the use of a 6-foot milling width in one pass. This led to remilling on a number of test sections. The remilling could have been eliminated by using a 12-foot milling width.
4) ADOT requirement of 4000 tons asphalt concrete production before paving SHRP section was critical and was not satisfied on one test section with recycled asphalt concrete. However, the SHRP requirements regarding production were fully met on all sections.
5) The requirements for asphalt concrete in ADOT standard specification section 416 for compaction were in conflict with SHRP requirements. This happened because of the fact that ADOT specifications required taking ten 4-inch diameter cores from random locations on the newly constructed pavement and density measurements in the laboratory on these cores. Since SHRP prohibits any coring on test sections, density measurements were made by the Nuclear gages. Though initial experimentation showed that all the gages used on the project were fairly consistent, some readings from the gages suspected to be wrong.

6) Compacted density problems were experienced on the left lanes of ADOT 2 and ADOT 4. Low density was also suspected on ADOT 10. However, where there was no end-product specifications for this section.

7) The measurements of compacted thickness on the second ribbon of paving was approximate and did not necessarily reflect the true thicknesses. Due to absence of coring, actual thicknesses could not be obtained.

8) The analysis of initial cost of different rehabilitation strategies revealed that thick overlays and the asphalt rubber asphalt concrete overlays were the most expensive strategies. However, asphalt rubber asphalt concrete costs were high due to higher bid price of the contractor.

RECOMMENDATIONS

Based on the experience of SPS-5 construction in Arizona, the following recommendations can be made:

1) The milling equipment should be capable of milling a minimum of 12 feet. The 6-foot milling width used on SHRP test sections produced differential milled depths. Also, the inspection was difficult with 6-foot milling width.

2) In order to ensure the tolerance in overlay thickness precisely, it is important that the test sections be surveyed before and during construction, especially if a wearing course is to be removed. The tolerances expected by SHRP were extraordinary and normal construction practices are not capable of producing such tolerances. Survey profiles should be performed to obtain the best tolerances possible.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the help of all from ATRC, ADOT, Corn Construction, Inc., International Surfacing, Inc. and SHRP involved with SPS-5 construction in making SPS-5 construction a success. Special thanks go to Mr's J.J. Liu, Greg Rollins, Dwight Metcalf and Mushtaqur Rahman of ATRC, Mr's Don Corum, Warren Goff and Mike Meyers of ADOT and Mr. Pete Parede of Jim Nichols Consulting, Chtd., SHRP consultant. The personal interest and advice of Mr. Frank McCullagh, former director of ATRC are highly appreciated.

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APPENDIX A

STRATEGIC HIGHWAY RESEARCH PROGRAM (SHRP)

SPECIFIC PAVEMENT STUDIES; EXPERIMENTAL DESIGN AND RESEARCH PLAN FOR

EXPERIMENT SPS-5: REHABILITATION OF ASPHALT CONCRETE PAVEMENTS

Specific Pavement Studies
Experimental Design and Research Plan
for Experiment SPS-5
Rehabilitation of Asphalt Concrete Pavements

INTRODUCTION

The studies of rehabilitation and overlay techniques were the strongest contenders for inclusion in Specific Pavement Studies (SPS) as determined by previous balloting of highway agencies. Participation in and support of the research plans by the state and provincial highway agencies indicates enthusiasm for early implementation of the plan. Successful completion of the research project SPS-5, "Rehabilitation of Asphalt Concrete Pavements," and the project SPS-6, "Rehabilitation of Jointed Portland Cement Concrete Pavements," will make major contributions to our ability to increase life of the existing primary highway system of the United States and Canada through proper use of rehabilitation and overlay techniques.

The experimental designs and research plans presented here for SPS-5 were adapted from the Specific Pavement Studies on hot recycling of asphalt concrete (AC) pavements originally described in the May 1986 <u>Strategic Highway Research Program Research Plans</u> issued by the Transportation Research Board. Some of the original experimental design factors have been revised based on state and province desires and budget limitations. These plans have been prepared by the SHRP in cooperation with state and provincial highway agency personnel participating in various meetings, including an SPS-5 workshop held in Washington, D.C., February 27-28, 1989. The recommendations of the participants from 23 states and provinces and FHWA are incorporated into the experimental design and research plan described in this report. This research plan will be used by highway agencies and SHRP as a guide for selecting candidate projects to be considered for inclusion in the SPS-5 experiment and for design and construction of the test sections.

PROBLEM STATEMENT

Many United States and Canadian highway agencies are faced with the difficult task of determining the best way to treat existing aging and deteriorating asphalt concrete pavements. Not only must they determine which rehabilitation procedures work best under which circumstances, but they must also determine the most appropriate time to apply such rehabilitation treatments. The problem is further complicated by the need to address an entire network of pavements at various levels of condition and age with limited funding resources.

Asphalt concrete overlays are the most widely used method for rehabilitation of asphalt concrete pavements in the United States. Pavement surface preparation and type and thickness of overlay are the most important details of such rehabilitation methods. Thus, determining the effects of these details on performance under a variety of circumstances is an area of urgently needed research that will help develop improved rehabilitation design procedures.

One of the major LTPP objectives is "To Develop Improved Design Methodologies and Strategies for the Rehabilitation of Existing Pavements." A generally accepted approach for evaluating pavement maintenance and rehabilitation alternatives is the use of pavement management concepts including life-cycle cost analyses of construction and rehabilitation activities. The ability to predict the performance and life expectancy of various rehabilitation strategies, with and without overlays, is essential to pavement management and life-cycle cost analyses. Consequently, the development of improved performance predictions models for various rehabilitation strategies is essential to achieving the LTPP objectives and should be one of the early products of the research.

OBJECTIVE

The objective of this study is to develop improved performance prediction models to be used for determining the additional pavement life that can be expected from application of a variety of asphalt concrete (AC) rehabilitation methods and strategies ranging from minimal to maximum investment in the rehabilitation treatment. The treatments being studied include combinations of surface preparations, overlay thicknesses, and AC overlay type. The study objective includes a determination of the influence of environmental region and initial pavement condition on the effectiveness of rehabilitation methods. Accomplishing this objective will provide substantially improved "tools" for use in pavement management and life-cycle cost analysis activities.

PRODUCTS

One of the primary specific products of this portion of the SHRP-LTPP research will be to evaluate and improve portions of the AASHTO Guide for Design Pavement Structures that pertain to pavement rehabilitation design methods, life-cycle cost analysis, and pavement management. The SPS-5 and SPS-6 experiments will provide uniform and structured field performance data upon which "Part III - Pavement Design Procedures for Rehabilitation of Existing Pavements" and the sections on pavement management and life-cycle cost analysis of the AASHTO Guide can be evaluated and improved. These products are a direct response to the first two objectives of the LTPP program, which are 1) to evaluate existing pavement design procedures, and 2) develop improved pavement rehabilitation design methods and strategies.

The structural overlay method for rehabilitation of existing pavements that is included in the AASHTO Guide is based on a thickness or structural deficiency approach that presumes the existing pavement is structurally inadequate for anticipated future traffic and climatic conditions. This experiment will provide means for the field verification of this design approach. In addition, these AASHTO design procedures are not applicable to non-structural deficiencies and other functional rehabilitation needs. However, these factors will be considered in this experiment.

This study will produce definitive data concerning AC pavement performance and extended life predictions, including the relative cost effectiveness of various rehabilitation methods and strategies involving the use of virgin and recycled asphalt mix, and ranging from minimum surface preparation with thin AC overlay to extensive surface preparation with thick AC overlay.

The key products from the proposed study will include the following:

1. Comparisons and development of empirical prediction models for performance of AC pavements with different intensities of surface preparation, with thin and thick AC overlays, and with virgin and recycled AC overlay mixtures.

2. Evaluation and field verification of the <u>AASHTO Guide</u> design procedures for rehabilitation of existing AC pavements with AC overlays, and other analytical overlay design procedures for AC pavements.

3. Determination of appropriate timing to rehabilitate AC pavements in relation to existing condition and type of rehabilitation procedures.

4. Development of procedures to verify and update the pavement management and life-cycle cost concepts in the <u>AASHTO Guide</u> using the performance prediction models developed for rehabilitated AC pavements.

5. Development of a comprehensive data base on the performance of rehabilitated AC pavements for use by state and provincial engineers and other researchers.

BENEFITS TO PARTICIPATING HIGHWAY AGENCIES

This experiment will provide the states and provinces with actual data on the cost and performance of alternative methods for asphalt pavement rehabilitation. These data are necessary for the accurate use of pavement management systems, including life-cycle cost analysis and predictions. In addition to these direct benefits, participating highway agencies will receive ancillary benefits as a result of direct involvement in the experiment. For example, the interactions between the agency's personnel and the SHRP staff, contract researchers, and highway personnel from other agencies will produce valuable insights and exchange of ideas.

To evaluate innovative rehabilitation designs and local practices, sponsoring states and provinces can construct additional test sections on or near the SPS experimental projects containing factors of special interest. For example, an agency interested in evaluating the performance of a proprietary product such as a recycling admixture, could construct additional test sections along with the national experiment test sections. SHRP will assist with the design, data collection, and performance evaluation of such experiments and will provide coordination for desired regional or partial experiment.

Another primary benefit to participating highway agencies is that a portion of the research will be conducted using the specific pavements and construction practices employed by the participating highway authority, allowing direct use of the results by the agency. Having test sections within a jurisdiction provides the opportunity for the authority to link performance measurements based on the local pavement evaluation techniques directly to the national pavement data base being developed by SHRP. For example, highway agencies using a Dynaflect or Roadrater deflection measurement device can develop correlations with the falling weight deflectometer measurements performed using SHRP equipment.

EXPERIMENTAL DESIGN

The recommended experimental design is shown in Table 1. It identifies the primary experimental factors and their relationships with each other. Table 1 identifies site-related factors across the top and rehabilitation treatments down the sides. Each column in this arrangement represents two project locations each of which incorporates several test sections. Each row represents a series of test sections with specific features to be constructed at each project location.

This experimental design is a coordinated research plan intended to produce data and performance information for a variety of overlay procedures constructed to extend the life of existing asphalt concrete pavements. The primary factors being studied are 1) the degree of surface preparation, 2) overlay material (recycled or virgin AC), 3) thickness of AC overlay, and, 4) environmental

Table 1. Experimental design for SPS-5, rehabilitation of asphalt concrete pavements.

FACTORS FOR MOISTURE, TEMPERATURE, AND PAVEMENT CONDITION / REHABILITATION PROCEDURES			WET				DRY			
			FREEZE		NO FREEZE		FREEZE		NO FREEZE	
			FAIR	POOR	FAIR	POOR	FAIR	POOR	FAIR	POOR
Surface Prep.	Overlay Material	Overlay Thickness	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8
Routine Maint. (Control)		0	xx	xx	xx	xx	xx	xx	xx	xx
Minimum	Recycled AC	2-inch	xx	xx	xx	xx	xx	xx	xx	xx
		5-inch	xx	xx	xx	xx	xx	xx	xx	xx
	Virgin AC	2-inch	xx	xx	xx	xx	xx	xx	xx	xx
		5-inch	xx	xx	xx	xx	xx	xx	xx	xx
Intensive	Recycled AC	2-inch	xx	xx	xx	xx	xx	xx	xx	xx
		5-inch	xx	xx	xx	xx	xx	xx	xx	xx
	Virgin AC	2-inch	xx	xx	xx	xx	xx	xx	xx	xx
		5-inch	xx	xx	xx	xx	xx	xx	xx	xx

* Each "x" designates a test section

I-8
Probably Fair

Subgrade Soil: Fine

Traffic: >85 KESAL/Year

(climatic) factors. Other considerations are 1) existing condition of pavement, 2) subgrade soil, and 3) traffic volume and load. In addition, the experiment will include other sections desired by the highway agency to evaluate local practices or innovative features.

SHRP fully recognizes that no agency is able to continue in service any test section, even for research purposes, that becomes unsafe or disruptive to traffic flow. When in the judgment of the highway agency, a test section reaches such a condition, it should be treated as considered appropriate by the state or provincial highway agency. Such sections will be removed from the study and SHRP will endeavor to obtain final condition data prior to their treatment by the highway agency.

Site Related Factors

Site related factors include the four climatic regions (wet-freeze, wet-no freeze, dry-freeze, and dry-no freeze) and two pavement conditions (fair and poor). These levels of climatic regions and pavement conditions will result in eight different study combinations. In addition, each test section will be replicated. Thus, 16 project sites are needed for this experiment. Where ever possible, replications will take place in different jurisdictions to allow a greater range of practices to be studied.

Climatic Factors

The climatic regions are, for the most part, the same as the environmental zones used in the General Pavement Studies (GPS) except they are not modified to correspond with state boundaries. Climatological factors at specific locations will be used for selection of SPS projects. For example, in this experiment, a project in the south east portion of Kansas could fall in the wet-freeze environmental zone, rather than in the dry-freeze zone as indicated on the GPS environmental zone map.

Wet climatic regions are considered to have a high potential for moisture presence in the entire pavement structure throughout most of the year. Dry climatic regions are considered to have a very little and low seasonal fluctuation of moisture in the pavement structure. Freeze regions include locations with severe winters that result in long-term freezing of the subgrade. No-freeze climatic regions are considered to have no long-term freezing of subgrade.

Pavement Condition Factors

The classification of existing pavement condition as fair or poor will be used primarily to screen candidate projects to provide a range of existing distress conditions. Distress condition surveys of all test sections will be made prior to rehabilitation to document pavement condition and distress. However, it is desirable that some type of a composite distress index be used by highway agencies to classify pavement condition when selecting candidate projects for submittal to SHRP. In view of the desire to immediately identify candidate projects for the 1989 construction season, agencies are urged to select projects that they classify as in fair or poor condition and provide details on the procedures used for such classification. This information will be used by the SHRP to further develop a distress index classification procedures for use in selecting the remaining candidate projects for the 1990 construction season.

A structural based classification of present pavement condition will be used because the rehabilitation procedures being studied are intended to overcome structural inadequacy. The types of distress to be included in the classification include cracking, patching, and rutting. The composite distress index will consider the extent and severity of each distress type. Although several types and degrees of distress may occur in a project, all test sections in a project are to be either in fair or poor condition and as the result of the same type of distress.

Other Site Factors

Other factors that contribute to pavement performance which are not included as study factors will be considered in the test site selection process to keep the experiment within a practical, implementable size.

This experimental design is intended for projects built on fine grained subgrade types and for traffic levels above 85 KESAL per year (outside lane) because they represent the situation of greatest concern and provide a sterner test of rehabilitation strategies. If projects sites meeting these criteria are not located, traffic levels as low as 50 KESAL per year and/or with coarse grained subgrade soils will be considered. However, all test sections in a site must have the same type of subgrade soil and traffic.

The proposed experimental design further constrains other factors through the site selection process as follows:

1. Only pavements that are still in their first performance period (i.e., no prior overlay) will be included in the study to allow quantification of the pavement condition prior to overlay (quantification is not possible for previously overlaid pavements).

2. Existing open graded friction courses should be removed by milling if the pavement is to be considered as a candidate project. The addition of an open graded friction course to the new overlay for safety or other reasons is allowed, but should not be considered part of the structural overlay thickness.

3. Only pavement sections that are at least 8 years old will be included in the study to avoid excessively young pavements. This criterion avoids confounding and is consistent with the age range of pavements being considered for rehabilitation.

4. All test sections in a project should have the same design details, construction quality, and should experience uniform traffic movement.

In addition, it is desired that the Structural Number (SN) for candidate pavements be between 0.8 and 1.2 times that computed using the AASHTO Guide procedure to avoid excessively weak or excessively strong pavement. However, a pavement with an SN outside the desired range will be evaluated and allowed if appropriate.

Rehabilitation Treatment Factors

$2^3 = 8 * 16 = 128$
16
144

Rehabilitation treatment factors include two levels of surface preparation, two types of overlay material, and two overlay thicknesses. This will result in eight test section combinations at each of the sixteen projects. In addition, each of the sixteen projects will include a control test section which will only receive routine maintenance (i.e., routine pot hole filling and crack repair and sealing). These additional control test sections will not receive rehabilitation treatment until they reached their terminal condition and are removed from the experiment.

Each of the eight test sections will receive one of the eight different rehabilitation approaches defined by the extent of surface preparation, the overlay material used, and the thickness of the asphalt concrete overlay. This brings the total number of test ~~sections (including~~ control sections) for the entire experiment to 144 on 16 project locations.

8 x9 = 72 test
\+ 72 control
144 total

Surface Preparation

The proposed surface preparation includes ~~a minimum~~ and intensive level. The minimum level consists of limited patching (filling pot holes), crack repair and sealing. The intensive level consists of cold milling of one to two inches of the entire surface layer plus any necessary crack repairs and sealing. The intensive level represents a premium level of surface preparation addressing geometry, rut removal, and removal of aged asphalt concrete along with provision for a high degree of bonding. Milling should be selected such that the milled surface does not coincide with a layer interface. For a given test section, the milled layer should be replaced with the same overlay material being used for the same section prior to placement of the overlay. This thickness should not be considered part of the overlay thickness. Removal of an open graded friction course should not be considered part of the milling for intensive surface preparation.

AC Mix Design

Problems will likely to develop if an agency or a contractor is required to design or build test sections that vary substantially from the normal practice and experience. For this reason, a standard AC overlay mix design is not required. However, to produce reasonably consistent mixes for the AC overlays using local materials and design procedures, the FHWA Technical Advisory T5040.27, "Asphalt Concrete Mix Design and Field Control" (March 10, 1988) shall be used as a guide by the state and provincial highway agencies. This advisory contains detailed recommendations for material selection, mix design, plant operation, and compaction.

Recycled Mix Constraints

The recycled asphalt concrete overlay material type will be further constrained to insure a reasonable level of consistency as follows:

1. The content of reclaimed asphalt pavement (RAP) in the recycled mix will be fixed at 30%. This reflects a widespread practice and construction/contractor capability, avoids potential problems associated with high RAP ratio mixes, and reflects current judgement that a high RAP ratio could be restrictive and not likely to add much information on the comparative effect or benefit of using recycled materials.

2. Only a soft asphalt cement, selected to provide the required consistency of the combined binders, will be used. This reflects the current practice and avoids problems associated with choosing a representative softening agent from numerous proprietary formulations. However, participating highway agencies may wish to consider the use of proprietary softening agents for additional test sections.

3. All RAP for the test sections of a project should be from the same source, but not necessarily from the project on which the test sections are located.

4. The recycled mixture should be designed to meet the same mixture specifications as the virgin asphalt concrete mix.

Overlay Thickness

The study design proposes a thin and thick overlay thickness. The thin overlay is defined as 2 inch thick overlay. The thick overlay is defined as 5 inch thick overlay. The surface course of the thick overlay will be of the same mix and thickness as the thin overlay. On milled sections, the same overlay material will be used to replace the milled layer, resulting in an overall overlay thickness equals the milled thickness plus the prescribed overlay thickness.

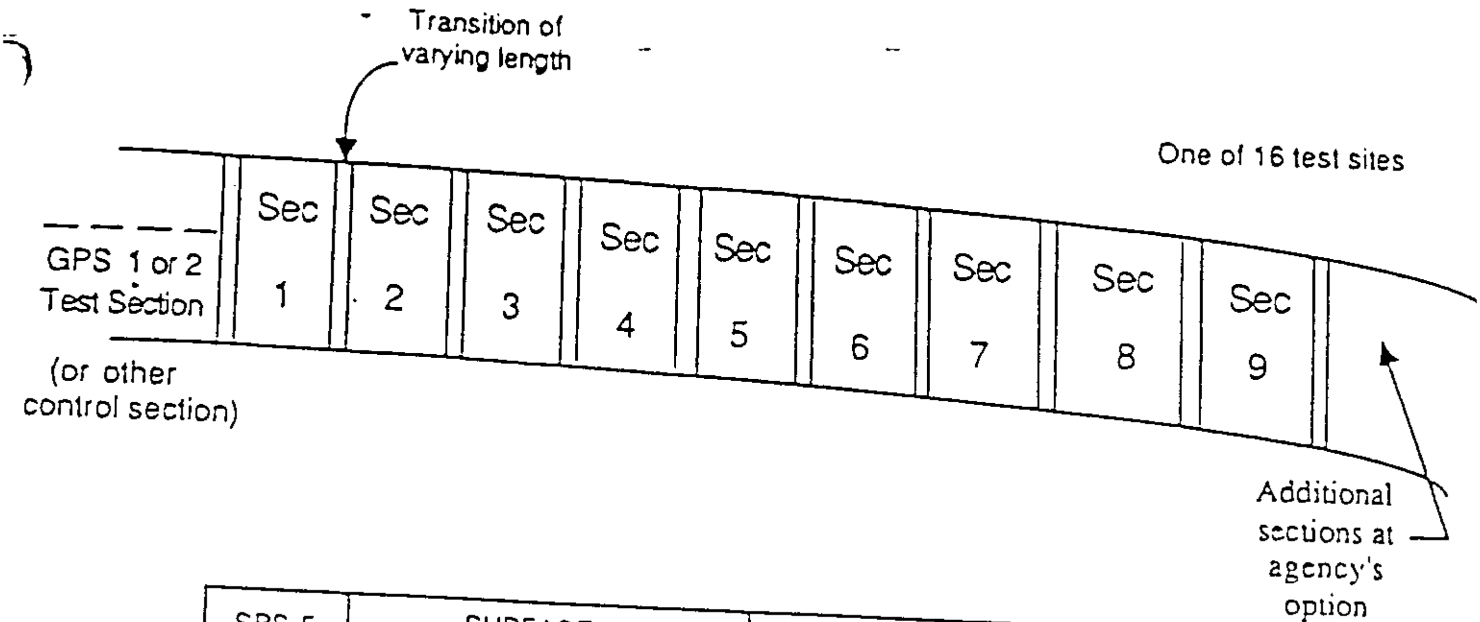
If desired by the highway agency, additional sections incorporating other features will be evaluated. These sections may include different overlay thickness, overlays with fabrics or fibers, other recycled asphalt mixes, large rock asphalt, or other features.

TEST SECTION SEQUENCE

what transition length?

The sequence shown in Figure 1 is not fixed and may be varied to accommodate local construction conditions. Each test section will be 500 feet in length. The sections will be separated by an appropriate transition length to meet practical construction considerations. Transition section length should be varied based on site conditions. Length should be adequate to accommodate material produced during changes in plant production (virgin vs. recycled). This will assure uniformity of the asphalt mix on the test section.

The sequence of the sections depicted in Figure 1 is not random. The sections are organized based on construction considerations involving surface preparation and overlay material type. This places recycled overlays of



SPS-5 SECTION	SURFACE PREPARATION	OVERLAY MATERIAL	OVERLAY THICKNESS
1	Routine Maintenance		0
2	Minimum	Recycled AC	2-inch
3	Minimum	Recycled AC	5-inch
4	Minimum	Virgin AC	5-inch
5	Minimum	Virgin AC	2-inch
6	Intensive	Virgin AC	2-inch
7	Intensive	Virgin AC	5-inch
8	Intensive	Recycled AC	5-inch
9	Intensive	Recycled AC	2-inch

Figure 1. Illustrative test section layout for SPS-5, rehabilitation of ashpalt concrete pavements.

different thickness adjacent to each other and allows a paver to move from one section to the next without changing materials. Under this approach the overlay thickness can be gradually modified over the transition area.

To help reduce the effort in identifying potential test sites for this experiment, several sources can be used. These include the agency's list of projects scheduled for rehabilitatin, projects identifed as candidates for GPS-6B, "New AC Overlay on AC Pavement", and projects included GPS-1, "Asphalt Concrete Pavements on Granular Base", and GPS-2, "Asphalt Concrete Pavements on Bound Bases". The use of GPS candidate projects will result in reduced data collection effort.

CONSTRUCTION CONSIDERATIONS

Construction problems and variations, as well as environmental conditions during construction could influence the performance of test sections to a great extent. Because construction procedures and control will be the responsibility of the many participating agencies, accurate records of actual construction procedures must be obtained (references to construction specifications will not be adequate). In addition, records must be maintained of weather conditions and events such as equipment breakdowns and material contamination during the test section construction. Testing during construction of the AC overlays will be required to encourage as much uniformity as possible. Guidelines will be developed to cover such items as compaction and air voids content, profile or roughness specifications for the finished overlay, and minimum sampling and testing for quality assurance and control. Field experience gained during the initial projects completed in 1989 will be used to develop these guidelines.

Although the test sections to be monitored are limited to the outside lane in one direction, it is desirable that all rehabilitation preparation activities and overlays be extended the full width of the pavement. Also to ensure uniformity, it is required that all test sections in each site be completed in one construction season.

Arrangements will be made for the collection of AC overlay samples for later testing by SHRP.

PARTICIPATING HIGHWAY AGENCY'S RESPONSIBILITIES

Participating highway agencies have and will play a major role in the development and conduct of the Specific Pavement Studies, including the following activities:

- Participation in experimental design and implementation plans
- Nomination of test sites
- Preparation of plans and specifications
- Selection of construction contractor
- Construction of the test pavements
- Construction inspection and management
- Provision of traffic control for all test site data collection
- Routine material sampling
- Collection and reporting of pavement inventory data
- Collecting periodic skid resistance measurements
- Conducting and reporting maintenance activities
- Collection and reporting of traffic and load data

SHRP RESPONSIBILITIES

SHRP responsibilities will include the following:

- Development of the experimental design
- Coordination among participating highway agencies
- Final acceptance of test sites
- Development of standard data collection forms
- Assistance with special sampling requirements
- Coordination of materials sampling and testing
- Monitoring of pavement performance
- Development of a comprehensive database and data entry
- Control of data quality
- Data analysis and reporting

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IMPLEMENTATION AND SCHEDULE

This SPS-5 research plan and experimental design is ready for implementation. However, its development was an evolutionary process and change is likely to continue with detailed adjustments as experience is gained from early projects.

Step one of implementation is the identification and submission by highway agencies of candidate projects for possible inclusion in the study. A total of 16 projects, 4 in each climatic region, will be required to complete the experiment as planned. SHRP desires to select and construct test sections on at least 2 or 3 projects during the 1989 construction season. The remaining sections will be selected from the identified candidates to be constructed in 1990. SHRP will assist the highway agencies in identifying candidate projects.

The existing condition of the test sections, in terms of distress, profile, deflections, and material characteristics, must be assessed prior to the rehabilitation and overlay activities. This will require extensive coordination between SHRP staff, regional offices, and the highway agencies. Traffic data must also be collected at each site using WIM equipment. It is required that the WIM equipment be installed within a year of the rehabilitation and perferably when the rehabilitation work is carried out.

The proposed schedule of activities for this experiment is as follows:

Nomination of Candidate Projects:	
- For 1989 Construction Season	April 30, 1989
- For 1990 Construction Season	May 30, 1989
Review and Screening of Candidate Projects	As received
Notification of State/Provinces of Accepted Projects	
- For 1989 Construction Season	June 1, 1989
- For 1990 Construction Season	July 15, 1989
Supplementary Recruitment Activities (with individual agencies)	As needed
Implementation Workshop with Participating Agencies	

- For 1989 Construction Season (with individual agencies)	As required by Participating Agency
- For 1990 Construction Season	Mid-August 1989

APPENDIX B

SPECIAL PROVISIONS AND ADDENDUM FOR PROJECT IR-8-2(91)

APPENDIX E

SPECIAL PROVISIONS AND ADDENDUM

Registered Professional Engineer
Certificate No.
5313
G.
RUNNER
Date Signed 1/11/90
ARIZONA, U.S.A.

SPECIAL PROVISIONS

FOR

ARIZONA PROJECT

IR-8-2(91)
008 PN 147 H0013 04 C

YUMA - CASA GRANDE HIGHWAY (I-8)
(County Line - Stanfield Rd. T.I. EB)

MILL AND RESURFACE

PROPOSED WORK:

The proposed work is located in Pinal County, on Interstate Route 8 (Eastbound) beginning at Milepost 147.60, and extending in a westerly direction to Milepost 160.87 approximately 17 miles southwest of the City of Casa Grande, for a distance of approximately 13.27 miles and consists of removal of asphaltic concrete pavement, embankment curb and trees; grading roadway for pavement and furnishing all materials and placing asphaltic concrete courses; furnishing and constructing embankment curb, guardrail, breakaway cable terminals, and concrete barriers; furnishing and applying thermoplastic pavement marking; and other incidental work.

(SPC87FA, 450/a, 11/24/89) DRAFT

SPECIFICATIONS:

The work embraced herein shall be performed in accordance with the requirements of the following separate documents:

Arizona Department of Transportation, Highways Division, Standard Specifications for Road and Bridge Construction, Edition of 1987,

Arizona Department of Transportation, Highways Division, Standard Drawings, listed in the project plans and defined hereinafter,

Arizona Department of Transportation, Traffic Control Manual for Highway Construction and Maintenance, January, 1989,

Manual on Uniform Traffic Control Devices for Streets and Highways, 1978, and Amendments, and

The Proposal Pamphlet and Non-bid Pamphlet which include the following documents:

These Special Provisions,

Required Contract Provisions All Federal-Aid Construction Contracts (Form PR 1273 Revised August, 1989),

Standard Federal Equal Employment Opportunity Construction Contract Specifications (Executive Order 11246), July 1, 1978, Revised November 3, 1980 and Revised April 15, 1981,

Notice of Requirement for Affirmative Action to Ensure Equal Employment Opportunity (Executive Order 11246), July 1, 1978, Revised November 3, 1980 and Revised April 15, 1981,

Compliance Reports, Federal-Aid Projects, February 1, 1977, Revised July 1, 1978, Revised November 3, 1980, Revised April 15, 1981, and Revised September 7, 1983,

Additional Required Contract Provisions Federal-Aid Contracts, Training Special Provisions, August 15, 1975,

Federal-Aid Proposal (Notices to Prospective Federal-Aid Construction Contractors), September 29, 1975,

Wage Determination Decision, and

Bidding Schedule,

GENERAL REQUIREMENTS:

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The average elevation of this project is 1630 feet.

The temporary lane lines on the I-8 (EB) ACFC course shall be pavement marking paint (10' stripe, 30' space), installed at the permanent location before the end of each day. The permanent thermoplastic striping shall be placed over the temporary paint stripes within two weeks after the completion of the I-8 (EB) ACFC course.

The contractor's attention is directed to the surveying requirements specified in the striping plan. Particular attention shall be paid to the end ramp taper extension detail (tapered lanes) on standard Drawing Number 4-M-1.09.

Existing pull boxes damaged as a result of the contractor's operations shall be removed and replaced with new pull boxes at the contractor's expense.

The contractor shall provide temporary positive measures to physically prevent debris from the concrete removal work at the existing bridges structure from falling over the underlying roadway. The contractor shall submit a plan and working drawings conforming to the requirements of Subsection 105.02, to the Engineer for approval prior to the start of any structural concrete removal work above any roadway.

Structural concrete within six inches above an existing bridge deck shall be removed with a hand held jack hammer.

The recycled salvaged pavement asphaltic concrete material to be used in the new recycled asphaltic concrete material shall come only from the mainline Milepost 151.15 to Milepost 160.87.

All of the asphaltic concrete friction course shall be removed from the full width of all ramps.

The milling operation shall not straddle the roadway centerline.

Asphaltic concrete (End product) and asphaltic concrete friction courses shall be placed by using a stringline as a horizontal guide. Stringline control nails shall be set at 100 feet interval on tangents and 50 feet interval on curves.

The contractor shall supply a suitable fully enclosed work area at the asphaltic concrete plant site to enable the Department to test the mineral aggregate in accordance with Arizona Test Method 105.

ADDITIONS AND REVISIONS TO THE STANDARD SPECIFICATIONS:

(ERATA100, 454/1, 09/30/88) DRAFT

STANDARD SPECIFICATIONS ERRATA:

The following changes shall be made to cover errors in the text of the Standard Specifications:

Page 27: The last sentence of the next-to-last paragraph shall read:

When such a condition is imposed, the contractor shall indicate the contractor's acceptance thereof in writing and such acceptance shall authorize the Department to deduct the contractor's share of the Department's costs from any monies due or that may become due to the contractor under the contract.

Page 41: The second sentence of Subsection 105.18(B) shall read:

Such demand for Arbitration shall be made by the claimant within 30 days measured from actual receipt of the State Engineer's decision, as provided for in Subsection 105.17 above.

The last sentence of Subsection 105.18(B) shall read:

The scope of the arbitration proceeding shall be restricted and limited to the matters presented to the State Engineer or authorized representative upon which the decision or determination was made and shall include no other matters.

The second sentence of Subsection 105.18(C) is hereby deleted.

In the last paragraph, the references to Subsections 108.07 and 108.08 are revised to read 108.08 and 108.09 .

Page 46: The first paragraph under Subsection 106.05(B), Certificate of Compliance: is revised to read:

The Engineer may permit the use of certain materials or manufactured assemblies prior to sampling and testing if those items are accompanied by Certificates of Compliance, stating that the materials involved comply in all respects with the requirements of the cited specifications. Such a certificate shall be furnished with each lot of material delivered to the project.

Item (7) of Subsection 106.05 (B) Certificate of Compliance: shall read:

The original signature of a person having legal authority to bind the manufacturer or supplier of the material. A reproduction is not acceptable. The signature shall be notarized.

Page 80: The ninth paragraph shall read:

Scales of acceptable size shall be furnished by the contractor and shall be sealed either by an inspector of the Department of Weights and Measures, State of Arizona, or by a registered service agency.

Page 111: The last paragraph of Subsection 203-5.04(A) shall read:

No measurement for payment will be made for structural excavation when structures are to be supported on piles or drilled shafts in new embankment sections.

Page 141: The last line of the first column of Table 305-2 shall read:

* less than 350

Page 145: The first sentence of the last paragraph of Subsection 401-3.03(C) shall read:

Forms shall remain in place until the day after placing the concrete and shall be removed in a manner that will prevent damage to the pavement.

Page 151: The second sentence of the third paragraph of Subsection 401-3.05(B) is hereby deleted.

Page 166: The first sentence of the first paragraph of Subsection 402-3.03 shall read:

Areas to be repaired will be designated by the Engineer and shall be repaired before any specified pavement grinding.

Page 260 The second sentence of the first paragraph of Subsection 409-5.02 shall read:

When such failure involves a deviation from the allowable asphalt property range, the payment to the contractor will be reduced by the amount determined through use of Table 404-1 of the Standard Specifications and the following formula:

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Page 264: The first paragraph of Subsection 410-3.07 shall read:

At least three pneumatic rollers conforming to the requirements of Subsection 406-10.08 (A)(2) shall be provided to accomplish the required rolling, except that the minimum air pressure in each tire shall be 100 pounds per square inch.

Page 334: In the next-to-last paragraph under Subsection 601-3.03(A) the reference to Subsection 401-3.03(D) is changed to 401-3.04(D).

Page 337: In the last paragraph under Subsection 601-3.03(F) the reference to Subsection 401-3.03(D) is changed to 401-3.04(D).

Page 408: The last sentence of the last paragraph under Subsection 701-3.01 shall read:

All devices provided under this section which are lost, stolen, destroyed or are deemed unacceptable by the Engineer, while their use is required on the project, shall be replaced by the contractor and, except as hereinafter specified for temporary impact attenuators, at no additional cost to the Department.

Page 621: The second paragraph shall read:

Concrete shall be Class S portland cement concrete conforming to the requirements of Section 1006.

(PLANS101, 450/m, 04/28/89)

SECTION 101 - DEFINITIONS AND TERMS:

101.34(A) Standard Drawings: of the Standard Specifications is revised to read:

Drawings approved for repetitive use, showing details to be used where appropriate.

All Standard Drawings approved by the Arizona Department of Transportation are listed in the project plans along with the latest revision dates, if any. The Standard Drawings are available in four separate bound sets: General Construction ("C") Standard Drawings; Structures Section Standard Drawings; Signing and Marking Standard Drawings; and Traffic Signal and Lighting Standard Drawings.

The original signature of a person having legal authority to bind the manufacturer or supplier of the material. A reproduction is not acceptable. The signature shall be notarized.

Page 80: The ninth paragraph shall read:

Scales of acceptable size shall be furnished by the contractor and shall be sealed either by an inspector of the Department of Weights and Measures, State of Arizona, or by a registered service agency.

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When such failure involves a deviation from the allowable asphalt property range, the payment to the contractor will be reduced by the amount determined through use of Table 404-1 of the Standard Specifications and the following formula:

Standard Drawings are available from:

Records Administration Section
Engineering Records
Arizona Department of Transportation
1655 West Jackson
Room 112F
Phoenix, Arizona 85007
(602) 255-7498

The cost of each set of Standard Drawings is $5.00. Single copies of each drawing are also available at $0.15 each. The above costs include postage. The minimum mail order is $1.00.

(NOBID102, 454/c, 04/14/89)

SECTION 102 - BIDDING REQUIREMENTS AND CONDITIONS:

102.03 Suspension from Bidding: of the Standard Specifications is modified to add:

The signature of the bid proposal by a bidder constitutes the bidder's certification, under penalty of perjury under the laws of the United States, that the bidder, or any person associated therewith in the capacity of owner, partner, director, officer, principal investor, project director, manager, auditor, or any position involving the administration of federal funds, has not been, or is not currently, under suspension, debarment, voluntary exclusion or been determined ineligible by any federal agency within the past three years. Signature of the bid proposal also certifies, under penalty of perjury under the laws of the United States, that the bidder does not have a proposed debarment pending. In addition, signature of the bid proposal certifies that the bidder has not been indicted, convicted, or had a civil judgment rendered against (it) by a court of competent jurisdiction in any matter involving fraud or official misconduct within the past three years.

Any exceptions to the above paragraph shall be noted and fully described on a separate sheet and attached to the bid proposal.

Included in the bid proposal pamphlet is an addendum to FHWA Form 1273, Required Contract Provisions, entitled "Appendix B - Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions", which has application to all lower tier transactions. Said addendum to Form 1273 shall be included by the contractor in all lower tier transactions. Submittal of a signed proposal by the lower tier subcontractor, supplier or vendor constitutes certification to all the stipulations therein.

If the proposal documents contain unauthorized alterations of words or figures or erasures not initialed by the person or persons signing the proposal or if there is a submission of any kind which may tend to make the proposal incomplete, indefinite or ambiguous as to its meaning.

If any of the unit prices quoted in the bidding schedule are unbalanced, either above or below the amount of a reasonable bid price, to the potential detriment of the Department.

(AWARD103, 450/o, 12/30/88)

SECTION 103 - AWARD AND EXECUTION OF CONTRACT:

103.02 Award of Contract: of the Standard Specifications is modified to add:

No award will be made to any contractor who is not a duly licensed contractor in accordance with Arizona Revised Statutes 32-1101 through 32-1170.03.

Licensing information is available from:

Registrar of Contractors
800 W. Washington
6th Floor
Phoenix, AZ 85007
Phone: (602) 542-1502

(SCOPE104, 450/A, 04/28/89)

SECTION 104 - SCOPE OF WORK:

104.02 Alterations or Modifications To Contract: is revised to read:

(A) Significant Changes In The Character of Work:

(1) The Engineer reserves the right to make, in writing, at any time during the work, such changes in quantities and such alterations in the work as are necessary to satisfactorily complete the project. Such changes in quantities and alterations shall not invalidate the contract nor release the surety, and the contractor agrees to perform the work as altered.

(2) If the alterations or changes in quantities significantly change the character of the work under the contract, whether or not changed by any such different quantities or alterations, an adjustment, excluding loss of anticipated profits, will be made to the contract. The basis for the adjustment shall be agreed upon prior to the performance of the work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the contractor in such amount as the Engineer may determine to be fair and equitable.

(3) If the alterations or changes in quantities do not significantly change the character of the work to be performed under the contract, the altered work will be paid for as provided elsewhere in the contract.

(4) The term "significant change" shall be construed to apply only to the following circumstances:

(a) When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction or

(b) When a major item of work, as defined elsewhere in the contract, is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125 percent of original contract item quantity, or in case of a decrease below 75 percent, to the actual amount of work performed.

(B) Suspensions of Work Ordered By The Engineer:

(1) If the performance of all or any portion of the work is suspended or delayed by the Engineer, in writing, for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the contractor believes that additional compensation and/or contract time is due as a result of such suspension or delay, the contractor shall submit to the Engineer, in writing, a request for adjustment within 7 calendar days of receipt of the notice to resume work. The request shall set forth the reasons and support for such adjustment.

(2) Upon receipt, the Engineer will evaluate the contractor's request. If the Engineer agrees that the cost and/or time required for the performance of the contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the contractor, its suppliers, or subcontractors at any approved tier, and not caused by weather, the Engineer will make an adjustment (excluding profit) and modify the contract in writing accordingly. The Engineer will notify the contractor of his/her determination whether or not an adjustment of the contract is warranted.

(3) No contract adjustment will be allowed unless the contractor has submitted the request for adjustment within the time prescribed.

(4) No contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided for or excluded under any other term or condition of this contract.

(C) Differing Site Conditions:

(1) During the progress of the work, if subsurface or latent physical conditions are encountered at the site differing materially from those indicated in the contract or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the contract, are encountered at the site, the party discovering such conditions shall promptly notify the other party in writing of the specific differing conditions before they are disturbed and before the affected work is performed.

(2) Upon written notification, the Engineer will investigate the conditions and if he/she determines that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, an adjustment, excluding loss of anticipated profits, will be made and the contract modified in writing accordingly. The Engineer will notify the contractor of his/her determination whether or not an adjustment of the contract is warranted.

(3) No contract adjustment which results in a benefit to the contractor will be allowed unless the contractor has provided the required written notice.

(4) No contract adjustment will be allowed under this clause for any effects caused on unchanged work.

104.04 Maintenance of Traffic: of the standard specifications is modified to add:

The contractor shall maintain a minimum one lane of traffic per direction on I-8 at all times.

The contractor shall maintain two lanes of traffic per direction on I-8 at night, on weekends, on holidays, and as directed by the Engineer, except as otherwise noted in the traffic control plans.

Lane closures on I-8 (EB) shall be in accordance with Figure 6.11 on page 97 of the 1989 ADOT Traffic Control Manual, except closures for median crossovers which shall conform to Figure 6.30 on Page 116 of the 1989 ADOT Traffic Control Manual. Shoulder closures on I-8 shall conform to Figure 6.29 on Page 115 of the 1989 ADOT Traffic Control Manual, and/or as directed by the Engineer.

The contractor shall maintain a minimum of one lane of traffic during crossroad work in accordance with Figure 6.7 on page 93 of the 1989 ADOT Traffic Control Manual. A high level flag tree shall be positioned at each flagging station on crossroads. Flaggers shall also be used at the junctions with off-ramps.

The contractor shall maintain a sufficient and safe width for traffic passage on each ramp under construction as directed by the Engineer. Whenever the Engineer allows ramps to be closed, the contractor shall not close two consecutive on-ramps or off-ramps simultaneously. Ramp closures shall conform to Figure 6.31 on page 117 of the 1989 ADOT Traffic Control Manual.

Traffic Control for SR 84 bridge work shall conform to note 19 of the project traffic control plans.

(QCONT106, 454/1, 05/31/89)

SECTION 106 - CONTROL OF MATERIAL:

106.04 Tests and Acceptance of Material: of the Standard Specifications is revised to read:

(A) Department Quality Acceptance:

All materials will be inspected, tested and approved by the Engineer prior to incorporation in the work. Any work in which materials not previously approved are used shall be performed at the contractor's risk and may be considered as unauthorized and unacceptable and not subject to the payment provisions of the contract.

Materials will be sampled and tested by a qualified representative of the Department unless otherwise specified in the special provisions. Copies of all test results will be furnished to the contractor's representative at the contractor's request.

Whenever a reference is made in the specifications to an Arizona Test Method, it shall mean the test method in effect on the day the advertisement for bids for the work is dated.

Whenever a reference is made in the specifications to a Federal Specification, or to a specification or test designation of the American Association of State Highway and Transportation Officials, the American Society for Testing and Materials, or any other recognized national organization, it shall mean the year of adoption or latest revision of the specification or test designation in effect on the day the advertisement for bids for the work is dated.

(B) Contractor Quality Control:

(1) General:

Quality control measures sufficient to produce materials of acceptable quality are the responsibility of the contractor; however, the specifications for certain products require specific quality control requirements. When so specified, the contractor is required to provide and maintain a Quality Control Plan, along with all the personnel, equipment, supplies and facilities necessary to obtain samples, perform tests, and otherwise assure the quality of the product.

The contractor shall be prepared to discuss and present, at the preconstruction conference, his understanding of the quality control responsibilities for specific items as included in the contract. The contractor shall submit the Quality Control Plan, for the appropriate items, to the Engineer for approval, a minimum of ten working days prior to the start of related work. The contractor shall not start work on the subject items without an approved Quality Control Plan. No partial payment will be made for materials subject to specific quality control requirements without an approved Quality Control Plan. As a part of the process for approving the contractor's plan, the Engineer may require the contractor's technician to perform testing of samples to demonstrate an acceptable level of performance.

The contractor shall perform process control sampling, testing and inspection during all phases of the work and shall perform the process control sampling, testing and inspection at a rate sufficient to assure that the work conforms to the contract requirements. The contractor shall provide the Engineer a certification stating that all of the testing equipment to be used is properly calibrated and will meet the specifications applicable for the specified test procedures.

(2) Quality Control Laboratory:

The Plan must include a laboratory or laboratories meeting the requirements of the Departments "System for the Evaluation of Testing Laboratories". The requirements may be obtained from the Materials Section, 206 S. 17th Avenue, Phoenix, Arizona 85007.

Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Engineer shall be permitted unrestricted access to inspect and review the contractor's laboratory facility. The Engineer will advise the contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting test results, the incorporation of the materials into the work will be halted immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

(3) Plan Administration and Technician Qualification:

The Plan shall be administered by an individual meeting one of the following requirements:

(a) Professional Engineer registered in Arizona with one year of highway experience acceptable to the Department.

(b) Engineer-In-Training certified by State of Arizona with two years of highway experience acceptable to the Department.

(c) An individual with three years of highway experience acceptable to the Department and with a Bachelor of Science Degree in Civil Engineering, Civil Engineering Technology or Construction.

(d) Construction Materials Technician certified at Level III by NICET.

(e) Highway Materials Technician certified at Level III by NICET.

(f) Highway Construction Technician certified at Level III by NICET.

(g) A NICET certified Engineering Technician in Civil Engineering Technology with five years of highway experience acceptable to the Department.

The individual administering the plan must be a full time employee of the contractor or a consultant engaged by the contractor. In either case, the individual employed shall have full authority to institute any and all actions necessary for the successful operation of the plan. The contractor's employee or consultant may supervise the quality control plan on more than one project if that person can be at the job site within one hour after being notified of a problem.

The Process Control Technician (PCT) and Quality Control Technician QCT) performing the actual sampling, testing and/or inspection shall meet one of the following criteria:

(h) Construction Materials Technician certified at Level II or higher by NICET in appropriate subfield.

(i) Those listed under (a) through (g) above, meeting the criteria for Plan Administrator, if they have a demonstrated proficiency in performing the appropriate test(s) or inspection function.

(j) Construction Materials Technician trainee under direct observation of an individual listed in (h) or (i) above.

(4) Sampling:

The Plan shall contain a statistical based procedure of random sampling which provides that all material being produced have an equal chance of being selected for sampling and testing. The Engineer shall be provided the opportunity to witness all sampling.

When directed by the Engineer, the contractor shall sample and test any material which appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or corrected by the contractor. All sampling shall be in accordance with standard AASHTO, ASTM or Department procedures.

(5) Testing:

All testing shall be performed in accordance with the acceptance test procedures applicable to the specified contract items or other methods set forth in the Quality Control Plan and approved by the Engineer. Should acceptance test procedures not be applicable to quality control tests, the plan shall stipulate which tests procedures will be utilized. The contractor shall provide copies of all test results to the Engineer upon request. Test results shall be furnished to the Engineer on forms furnished by or otherwise meeting the approval of the Engineer.

(6) Records:

The contractor shall maintain complete testing and inspection records and make them available to the Department for review and copies as requested.

Linear control charts shall be maintained by the contractor. Control charts shall be posted in a location satisfactory to the Engineer and shall be kept up to date at all times. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the upper and/or lower specification limit applicable to each test parameter, and the contractor's test results. The contractor shall use the control charts as part of a process control system for identifying production and equipment problems and for identifying potential pay factor reductions before they occur. If the contractor's projected data, during production, indicates a potential problem and the contractor is taking no satisfactory corrective action, the Engineer may halt production or acceptance of the material.

(DMAT106, 450/q, 02/24/88)

SECTION 106 - CONTROL OF MATERIALS: of the Standard Specifications is modified to add:

106.14 Domestic Materials:

Cement used on this project may be foreign or domestic.

The manufacturing processes to produce all steel products used on this project shall occur in the United States; however, raw materials used in manufacturing the steel products may be foreign or domestic. Steel not meeting these requirements may be used in products on this project provided that the invoiced cost to the contractor for such steel products incorporated into the work does not exceed either one-tenth of one percent of the total (final) contract cost or $2,500, whichever is greater.

The contractor shall furnish the Engineer with one or more affidavits, certificates, etc. which state that steel products utilized on the project meets the requirements specified hereinbefore. Such documents shall meet the requirements of Paragraph(s) 106.05(A) - Certificates of Compliance, and shall additionally identify whether the steel products are domestic or foreign.

TK/ldp/tja/jj/jkg/2129v/2232v
11/20/89

Special Provision
IR-8-2(91)
008 PN 147 H0013 (

SECTION 107 - LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC: (SAFE107, 454/6, 03/17/89

107.07 Sanitary, Health and Safety Provisions: of the Standard Specifications is modified to add:

Occupational Safety and Health Standards shall apply at all times. Should the contractor fail to follow OSHA regulations, the Engineer may suspend the work by written notice until compliance, and any such failure to comply with OSHA regulations shall constitute a waiver of any right to claim for such suspended work. If regulations are in conflict, the more strict regulation will apply.

107.08 Public Convenience and Safety: the third paragraph of the Standard Specifications is revised to read:

The contractor shall submit a Safety Plan to the Engineer at the preconstruction conference detailing the procedures the contractor will implement to satisfy OSHA and the State Occupational Safety Guidelines related to the worker as well as public safety in the construction of excavations, structures and confined air spaces as identified by the Engineer. The contractor's Safety Plan shall include the wearing of hard hats while within the project limits.

The Safety Plan submitted by the contractor shall include proposed methods to prevent unauthorized persons from gaining access to the work areas.

In conjunction with the Safety Plan, the contractor shall furnish and install 72-inch temporary chain link fencing, satisfactory to the Engineer, around all major structure construction areas (i.e., bridges, pumphouses, drop structures, retaining walls, etc.) and around any unattended excavation deeper than four feet, with slopes steeper than 2:1. Temporary fencing shall completely enclose the referenced construction activity and shall be secured after normal working hours to prevent unauthorized access.

Temporary fencing, when no longer needed to restrict access to the work site, may be used to construct permanent fence with the exception that materials which are unusable, in the opinion of the Engineer, due to either appearance or structural defects, shall be replaced with new materials. No direct measurement or payment will be made for furnishing or installing temporary fencing. Permanent fencing will be reimbursed under the appropriate bid items.

Unless otherwise approved in writing by the Engineer, open utility trenches shall be limited to 50 feet in length during non-working hours and shall be covered with steel plate in a manner satisfactory to the Engineer.

(UTIL107, 450/s, 09/30/88)

107.19 Contractor's Responsibility for Utility Property and Services: of the Standard Specifications is modified to add:

The contractor's attention is directed to the requirements of A.R.S. 40-360.21 through .29 requiring all parties excavating in public streets, alleys or utility easements to first secure the location of all underground facilities in the vicinity of the excavation.

At least 48 hours prior to commencing excavation, the contractor shall call Blue Stake Center, between the hours of 7:00 A.M. and 4:30 P.M., Monday through Friday for information relative to the location of buried utilities in the following project location:

Casa Grande	(602)836-8255

The following utility companies have facilities in the area, but are not anticipated to be in conflict.

U.S. West	Curt Neyman	(602)726-3240
AT & T	John Landers	(602)629-8758

It shall be the contractor's responsibility to determine the exact location of all utilities prior to any construction operations and to notify the above mentioned utility companies at least five (5) working days prior to commencing any work on the project.

The contractor shall secure and review copies of all existing ADOT permits within the project limits, prior to the start of construction, to assist the contractor in determining the location of any utilities, which the Department may have record of and which are not otherwise identified. The providing of copies of permits by the Department is for information only and shall not relieve the contractor of responsibility for identifying, locating and protecting any existing utility lines. Copies of permits may be obtained from the Area Permit Supervisor as listed below:

<u>DISTRICT II</u>

Tucson Office	(602)628-5601	301 S. Euclid #4001 Tucson, AZ 85726

(SUBC108, 450/y, 04/14/89

SECTION 108 - PROSECUTION AND PROGRESS:

108.01 Subletting of Contract: the second paragraph of the Standard Specifications is revised to read:

"His own organization" shall be construed to include only workmen employed and paid directly by the prime contractor and equipment owned or rented by him, with or without operators. Such term does not include employees or equipment of a subcontractor, assignee, or agent of the prime contractor.

108.01 Subletting of Contract: of the Standard Specifications is modified to add:

The contractor shall provide to the Engineer a complete copy of each subcontract and lower tier subcontract. Each subcontract and lower tier subcontract shall include all of the required contract provisions including, but not limited to, the Equal Employment Opportunity Provisions, FHWA Form 1273, Required Contract Provisions, and the addendum thereto entitled "Appendix B - Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions" and the Wage Determination Decision, if these Provisions are made part of the prime contract. The Engineer will not consent to subletting of any portion of the contract if a copy of the subcontract or lower tier subcontract is not received. The Engineer's consent shall in no way be construed to be an endorsement of the subcontractor or its ability to complete the work in a satisfactory manner.

Contractors shall not sublet to subcontractors who are not duly licensed contractors in accordance with Arizona Revised Statutes 32-1101 through 32-1170.03.

Further information regarding licensing may be obtained by contacting:

Registrar of Contractors
800 W. Washington
6th Floor
Phoenix, AZ 85007
Phone: (602) 542-1502

The following items are hereby designated as Specialty Items:

6040001, 7040003 through 7350010

(LIQDM108, 450/Z, 09/30/89)

SECTION 108 - PROSECUTION AND PROGRESS:

108.09 Failure to Complete the Work on Time: the Schedule of Liquidated Damages of the Standard Specifications is revised to read:

Original Contract Amount		Daily Charge	
From More Than	To and Including	Calendar Day or Fixed Date	Working Day
$ 0	$ 25,000	$210	$300
25,000	50,000	250	350
50,000	100,000	280	400
100,000	500,000	490	700
500,000	1,000,000	770	1,100
1,000,000	2,000,000	910	1,300
2,000,000	5,000,000	1,190	1,700
5,000,000	10,000,000	1,750	2,500
10,000,000	----------	2,100	3,000

(FORCE109, 454/2, 10/26/89)

SECTION 109 - MEASUREMENT AND PAYMENT:

109.04 (B)(3) Equipment: of the Standard Specifications is modified to add:

Following is a rate adjustment factor table to be utilized with the Blue Book rates in adjusting rates for equipment used on force account work.

RATE ADJUSTMENT FACTOR TABLE

Year of Manufacture	Adjustment Factor
1989 and later	1.00
1988	.970
1987	.964
1986	.956
1985	.948
1984	.940
1983	.933
1982	.911
1981	.881
1980 or earlier	.856

109.08 Payment of Withheld Funds: the last paragraph of the Standard Specifications is revised to read:

The securities will be deposited in a joint escrow account to be held by a bank or savings and loan institution licensed by the state whose principal office is in Phoenix and in an amount at all times equal to or greater than the amount that would normally be withheld under the provisions of Subsection 109.06.

(SCUT202, CS, 09/01/87)

ITEM 2020201 - SAW CUTTING:

The work under this item shall consist of saw cutting the existing pavement where new asphaltic concrete is to match existing bituminous surfaces with no provisions for overlaying the entire section. This item shall also include saw cutting of existing portland cement concrete pavement, sidewalks, driveways and parking lots where new construction shall match the grade of existing surfaces that are to remain where called for on the project plans or where designated by the Engineer.

Saw cuts shall be made to a minimum depth of 1 1/2 inches and in all cases deep enough to insure a neat vertical joint. Portland cement concrete designated to remain, that is damaged by the saw cutting, shall be replaced in kind at the contractor's expense.

Measurement of this work will be made horizontally at each location to the nearest tenth of a linear foot.

Payment for this work will be made at the contract price per linear foot for ITEM 2020201 - SAW CUTTING, which price shall be full compensation for the work, as described and specified herein and on the project plans.

Payment will be made on the total length of saw cut to the nearest foot.

ITEM 2020065 - Removal of Trees:

Description:

The work under this item shall consist of the removal of trees, individually marked by the Engineer throughout the project right-of-way limits among the roadway shoulders, slope, dyke, structures and drainage work areas.

Construction Requirements:

The marked trees shall be removed flush with existing ground level by cutting. Use of stump cutter may be required to achieve a flush ground condition. The trees shall be either hauled from the project or chipped and spread on the adjacent slopes inside the project right-of-way limits and as directed by the Engineer. Larger sections of trunks or limbs not suitable for chipping shall be removed from project site. Spreading and removal work shall be completed within the same working day of cutting the trees.

To prevent resprouting, the remaining stumps, within 15 feet from edge of pavement, shall be treated with a herbicide, Weedon BK 64 or an approved equal, following manufacturer's recommendations.

Method of Measurement:

Removal of trees will be measured as a unit for each. A tree having several trunks protruding from one base shall be measured as one tree.

Basis of Payment:

The accepted quantities of removal of trees, measured as provided above, will be paid for at the contract unit price each, which price shall be full compensation for the item complete, as herein described and specified.

(ACREM202, 451/A, 05/31/89)

SECTION 202 - REMOVAL OF STRUCTURES AND OBSTRUCTIONS:

202-3.03 Removal of Pavement:

202-3.03(C) Bituminous Pavement For Recycle: of the Standard Specifications is revised to read:

202-3.03(C) Bituminous Pavement Removal By Milling:

When milling is specified, the existing asphaltic concrete shall be removed in accordance with the details shown on the project plans with equipment specifically designed to remove such material by means of grinding or chipping to a controlled line and grade. The equipment used shall be capable of removing the existing asphaltic concrete within 0.01 foot of the specified removal depth. The removal shall be accomplished in a manner which does not destroy the integrity of any asphaltic concrete pavement that remains and which does not result in a contamination of the milled asphaltic concrete with the underlying base material.

Removal of the existing asphaltic concrete at structures shall be by equipment and methods that will not damage the existing bridges deck. The deck and approach slabs shall be throughly cleaned to the satisfaction of the Engineer.

Upon removal, the existing asphaltic concrete material not used for recycled asphaltic concrete shall become the property of the contractor with the stipulation that it shall be salvaged for future use as recycled asphaltic concrete.

No measurement or direct payment will be made for the hauling and disposing of the milled asphaltic concrete material, the cost being considered as included in the price of contract item 2020029.

Under no circumstance shall the removal of existing asphaltic concrete begin until the mix design for replacement asphaltic concrete has been approved by the Engineer.

The extent of removal of existing asphaltic concrete must be in keeping with the contractor's ability to produce, haul, place and compact replacement asphaltic concrete so that at all times the length of open "trench" is at a minimum. If the contractor's production of replacement asphaltic concrete is stopped for any reason, the removal of asphaltic concrete shall either cease or shall be reduced. The Engineer will be the sole judge as to whether the removal shall cease or be reduced and his decision will be based on the reason for the stoppage in asphaltic concrete production, the expected length of the stoppage, the type and depth of the material being removed, and the time of day.

Replacement asphaltic concrete shall be placed as soon as possible after the "trench" has been opened up. The surface on which the material is to be placed shall be uniform and free of loose material. Any exposed base material shall be compacted to the extent required by the Engineer.

The "trench" in which asphaltic concrete is being placed shall be filled before the end of each day's work and the lane shall be opened to traffic. The length of open "trench" at any one time shall not exceed two miles or 1/2 the length of the work, whichever is the lesser.

In the event of circumstances beyond the control of the contractor, such as equipment breakdown, or if the production of the replacement asphaltic concrete has been stopped by the Engineer and the contractor is unable to comply with the requirements in the preceding paragraph, the contractor shall provide and maintain such traffic control devices that the Engineer deems necessary under the circumstances in order to provide safe and efficient passage through the work zone.

If the Engineer deems it to be warranted, he will require that the contractor provide for the surface drainage of areas where the pavement surface has temporarily been removed.

Pavement, to be removed by milling, adjacent to manholes, valve boxes, small radius curbs and other fixed objects that produce confined areas shall be removed with milling equipment specifically designed to operate in restricted areas and capable of removing asphaltic concrete of the specified thickness without damage or displacement of the adjacent object.

On projects with existing curb and gutter, any asphaltic concrete buildup in the gutter designated to be removed, shall be removed prior to the pavement removal operation by equipment and methods approved by the Engineer. The equipment and methods used shall be capable of removing the asphaltic concrete buildup without causing damage to the curb and gutter.

202-3.09 Removal of Guard Rail: of the Standard Specifications is modified to add:

The contractor shall salvage, and haul all removed guard rail and cattle guards which the Engineer deems useable, to the ADOT Casa Grande Maintenance Yard. The contractor shall give 24 hours notice to the Maintenance Supervisor Mr. John Eide at phone number (602) 836-2240 before making delivery.

The guard rail and cattle guards shall be stockpiled at the location and in a manner approved by the Engineer.

202-4 Method of Measurement: of the Standard Specifications is modified to add:

Remove and Salvage cattle guards will be measured by the unit each.

Removal of asphaltic concrete pavement (Milling) will be measured by the square yard of pavement removed.

Remove and salvage guard rail, and removal of embankment curb will be measured by the linear foot along the face of the guard rail, and embankment curb element.

Measurement for the removal of embankment curb will exclude the lengths occupied by downdrain and spillway inlets.

SECTION 203 - EARTHWORK:

203-9 Borrow:(Shoulder Build-up & BCT Pads)

203-9.02 Materials: of the Standard Specifications is modified to add:

Pit Serial Number: 5599, Area I

Material Designation: Borrow

Location and Description:

Material Source #5599 is located approximately 1.4 miles south of I-8 at Station 1822 (Hidden Valley Interchange, MP 151.68), in an existing pit in the channels of an unnamed wash 25 miles west of the City of Casa Grande. The pit lies in Sec. 14; T. 7S; R. 2E in Pinal County.

The material in Area I of the pit primarily consists of 4.5 to 10.5 feet of sandy gravel with fine sand and silt, and local traces of clay sand (SC) and clay gravel (GC). An underlying deposit of lightly clay-coated sand and gravel is present over most of the pit. Local occurrences of tuff, conglomerate and granite were noted above the floor of the excavated areas and on the east and west banks of the wash.

Extraction of Pit Material:

Moderate clearing of grass, brush, large palo verde, Ironwood, Mesquite trees and Cacti will be necessary. No stripping will be required.

The estimated quantity of material available, with an average depth of 4 feet, is 45,000 cu. yds.

Investigation:

A total of 7 test holes were dug in Area I of the pit for sampling in April, 1980. These test holes were dug to depths of 4.5 to 10.5 feet. No water was encountered in any of the test holes at the time of investigation.

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Should the contractor elect to use other sources of borrow material, then the borrow material shall conform to the following gradation:

Sieve	% Passing
1 1/2"	100
#4	30 - 70
#200	2 - 25

Plasticity Index 5 - 25

203-9.03 Construction Requirements: of the Standard Specifications is modified to add:

Borrow material for shoulder build-up shall be compacted in accordance with the requirements specified under Item 2031001, "COMPACTION OF SHOULDER MATERIAL," of these Special Provisions.

Information Available to Bidders.

The following information is available at ADOT Materials Section, located at 206 South 17th Avenue, Phoenix, Arizona, 85007:

1. Test hole logs and laboratory test results of April, 1980 investigation.

2. Aerial photographs and topographic maps of the pit area.

Haul Road and Haul Distance:

Moderate to heavy blade work will be necessary to reconstruct an existing haul road from the pit area to the Interstate 8 frontage road at Hidden Valley interchange, a distance of approximately 1.4 miles. The average haul distance to MP 147.60 on I-8 is 5.5 miles.

Haul loads must be within legal limits on paved roadways.

(SHOLD203, CS, 09/01/87)

ITEM 2031001 - COMPACTION OF SHOULDER MATERIAL:

The work under this item consists of the compaction of the material used to reshape the shoulders as shown on the project plans and/or as specified elsewhere herein. No density requirement is specified for this material; however, compaction will be required for all areas deemed practicable by the Engineer.

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The equipment proposed for obtaining this compaction shall be of a type approved by the Engineer and the extent of compaction required will be determined by the Engineer.

Measurement for this work will be made, regardless of type of equipment used, by the hour for the compacting unit, but only for the time that the unit is actually used for compacting the shoulder material, except that in any half-shift during which the unit is operated for necessary compaction, measurement will be made for the full half-shift, provided that the unit is not inoperative due to breakdown or other causes determined by the Engineer to be the responsibility of the contractor.

Payment for this work will be made at the contract price per hour, which price shall be full compensation for the item complete, as herein described and specified.

(WATR206, 451/W, 08/24/89)

SECTION 206 - FURNISH WATER SUPPLY:

206-5 Basis of Payment: of the Standard Specifications is modified to add:

When the bidding schedule does not contain a contract pay item for furnish water supply, full compensation for either developing or obtaining an adequate water supply and furnishing all water required for the work shall be considered as included in the prices paid for the various contract items of work requiring the use of water.

(BITR404, 451/O, 08/25/89)

SECTION 404 - BITUMINOUS TREATMENTS:

404-3.13 Fog Coat: of the Standard Specifications is revised to read:

The type of bituminous material shall be ERA-25, diluted with one (1) part water to one (1) part ERA-25 and shall be applied at the approximate rate of .08 gallon per square yard.

When a fog coat is specified for new asphaltic concrete, it shall be applied as soon as practicable after placing the asphaltic concrete.

Blotter material shall be applied to the treated surface in one or more application for a total application of approximately 2 pounds per square yard at a time specified by the Engineer and before opening the roadway to traffic.

404-4 Method of Measurement: the fifth, sixth, seventh and eighth paragraphs of the Standard Specifications relating to time to apply tack and provisional seal coats are hereby deleted.

404-5 Basis of Payment: the eighth and ninth paragraphs of the Standard Specifications are revised to read:

The unit price for bituminous tack coat is deemed to be the cost to furnish, transport, store and apply asphalt cement or emulsified asphalt at the project location. Payment for bituminous tack coat will be made at the unit price multiplied by the respective payment factor, listed under Subsection 404-3.12, and adjusted to the nearest dollar.

The accepted quantity of bituminous tack coat, measured as provided above, will be paid at the contract unit price per ton adjusted as provided above which price shall be full compensation for furnishing, transporting, storing and applying the exact type, grade or designation of bituminous tack coat specified by the Engineer.

404-5 Basis of Payment: the tenth, eleventh, twelfth, thirteenth and fourteenth paragraphs of the Standard Specifications are hereby deleted.

SECTION 406 - ASPHALTIC CONCRETE: of the Standard Specifications is modified to add:

ITEM 4060053 - ASPHALTIC CONCRETE (MODIFIED)(ASPHALT RUBBER):

Description:

The work under this item, hereinafter asphaltic concrete, shall consist of furnishing all materials, mixing at a plant, hauling, and placing a mixture of an aggregate and bituminous material to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans, the requirements of these Special Provisions, and as directed by the Engineer.

The contractor shall be responsible for all adjustments to his equipment necessary to properly accommodate the use of asphalt rubber as a bituminous material.

Materials:

Mineral Aggregate:

There is no Department-furnished source of mineral aggregate. The contractor shall provide a source in accordance with the requirements of Section 1001 of the Standard Specifications.

Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods.

Mineral Aggregate Characteristics	Test Method	Requirement
Combined Bulk Specific Gravity	AASHTO T 85 Arizona Test Method 211	2.35 - 2.85
Combined Water Absorption	AASHTO T 85 Arizona Test Method 211	0 - 2.5
Sand Equivalent	AASHTO T 176	Minimum 55
Crushed Faces	Arizona Test Method 212	Minimum 70%
Abrasion	AASHTO T 96	100 Rev., Max 9% 500 Rev., Max 40%

The mix design grading limits for mineral aggregate shall be as follows:

Sieve Size	Percent Passing
1/2 inch	100
3/8 inch	80 - 90
1/4 inch	40 - 60
No. 8	20 - 30
No. 40	5 - 15
No. 200	0 - 2.5

During the production of asphaltic concrete, mineral aggregate gradation shall be tested for acceptance in accordance with the requirements of Subsection 406-9.03(A).

Bituminous Material:

Bituminous material shall be asphalt-rubber (vulcanized) and shall conform to the requirements of Section 1009 of the Standard Specifications, except for the following:

The rubber shall conform to the following gradation:

Sieve Size	Percent Passing
No. 10	100
No. 16	75 - 100
No. 30	25 - 100
No. 50	0 - 45
No. 100	0 - 10
No. 200	0 - 5

The asphalt rubber binder shall conform to the following requirements:

Parameter	Requirement
Viscosity, Haake, 350F	1500 - 4000 cp.
Cone Penetration, 77F (ASTM D1191)	20 min.
Softening Point, F (ASTM D36)	125F min.
Resilience, 77F (ASTM D3407)	15 % min.

During the production of asphaltic concrete, the contractor shall maintain on the site a nuclear asphalt content gauge calibrated on the material being tested in accordance with the gauge manufacturer's recommendations. Asphaltic concrete asphalt rubber content shall be measured by the contractor by means of the nuclear asphalt content gauge a minimum of four times per full shift. Production of asphaltic concrete shall cease immediately and the plant recalibrated if the Engineer determines the percent of bituminous material has varied by an amount greater than 0.5± percent from the amount directed by the Engineer. During the production of asphalt rubber, the contractor shall maintain on site equipment necessary to measure the viscosity of the mixture. The mixture shall be maintained between 1500 and 4000 centipoise at 350F. Mixture viscosity shall be checked at the direction of the Engineer.

For comparative purposes, quantities shown in the bidding schedule have been calculated based on the following Data:

	Asphaltic concrete (Modified)(Asphalt Rubber)
Unit Weight, Pounds Per Cubic Foot	146.00
Percent, Asphalt Rubber	6.5

Mix Design Proposal:

A fifty pound sample from each stockpile of mineral aggregate shall be furnished to the Engineer, along with a letter from the contractor explaining in detail his proposed methods of producing mineral aggregate, including the expected wasting, washing, blending, proportioning, etc., to produce asphaltic concrete that meets the requirements and gradation as specified herein and any special or limiting conditions that he may propose.

Along with these aggregate samples the contractor shall furnish a minimum 10 pound sample of the granulated rubber proposed for use, one gallon of AC-10 asphalt cement from the intended supplier, and two gallons of the proposed mixture of asphalt and rubber.

The Department will, within 10 working days of receipt of all samples in the Central Laboratory, provide the contractor with the percentage of bituminous material to be used in the mix, the percent of aggregate material passing each required sieve, and any special or limiting conditions for the use of the mix.

Construction Requirements:

The asphaltic concrete shall be constructed in accordance with the requirements of Subsection 406-10 and the following modifications and additions:

General:

The surface upon which the asphaltic concrete is to be placed shall be cleaned of all objectionable material and tacked with a light coat of bituminous material. The cleaning of the surface, the tacking of the surface, and amount of bituminous material used shall be as directed by and acceptable to the Engineer.

Just prior to being placed, the asphaltic concrete shall be in a thoroughly mixed condition, free of lumps and crusts, and be in a free flowing, workable condition.

Proportioning:

The asphalt cement stall be modified by the addition of a minimum of 20 percent of granulated rubber, by weight of the asphalt unless otherwise approved by the Department's Central Laboratory.

The asphalt cement and rubber shall be combined prior to the incorporation into the asphaltic concrete for a period of at least one hour; however, the mixture of asphalt cement and rubber should not be held at temperatures over 350 degrees F. for a period over 10 hours. The temperature of the asphalt cement shall be between 350 and 400 degrees F. at the time of the addition of the granulated rubber. Temperature of the asphalt rubber mixture shall be maintained between 325 and 375 degrees F. during the one hour reaction period.

Compaction:

The temperature of asphaltic concrete just prior to compaction shall be at least 275 degrees F.

Compaction shall be accomplished by the following sequence and coverage of rollers.

A minimum of four (4) Static Steel Wheel rollers shall be provided. The drums shall be of sufficient width that when staggered, two (2) rollers can cover the entire width of the ribbon with one (1) pass. Two of these rollers shall be used for initial breakdown and maintained no more than 150 feet behind the paving machine. The remaining two rollers shall follow as closely behind the initial breakdown as possible. As many passes as is possible shall be made with the second set of rollers before the temperature of the asphaltic concrete falls below 220 degrees F.

Static Steel Wheel compactors shall weigh not less than eight tons. The rollers shall be self-propelled and shall be operated with the drive wheel in the forward position. Vibratory rollers may be used in the static mode only. All rollers shall be equipped with pads and a watering system to prevent sticking of the asphaltic concrete mix to the steel wheels.

In order to achieve, as far as practicable, a continuous operation, the speed of the paving machine shall be coordinated with the production of the plant. At no time shall the paving machine be stopped for more than three minutes. In the event a three minute or longer delay occurs the paving machine shall be pulled away from the mat in order for the rollers to compact this area in accordance with the above temperature limitations.

The rollers steel wheels shall be wetted with water or, if necessary, soapy water to prevent mix pick-up during rolling. The Engineer may change the number of coverages or sequence if, in his judgement, the change is necessary to prevent picking up of the asphaltic concrete.

Asphaltic concrete will be accepted complete in place, if, in the judgement of the Engineer, the asphaltic concrete reasonably conforms to the requirements specified herein. Asphaltic concrete that is not acceptable and is rejected shall be replaced to the satisfaction of the Engineer and at no expense to the Department.

Method of Measurement:

Asphaltic concrete will be measured by the ton for the mixture actually used, which will include the weight of mineral aggregate, bituminous material, and any necessary blending material. Measurement will include any weight used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

Asphalt-rubber material will be measured by the ton in accordance with the requirements of Section 1009 of the Standard Specifications.

BASIS OF PAYMENT:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price per ton for bituminous mixture, which price shall be full compensation for the work, complete in place, as specified herein.

Payment for the asphalt-rubber will be made by the ton of the mixture, including asphalt cement and granulated rubber.

(ACF407, CS, 10/27/87)

SECTION 407 - ASPHALTIC CONCRETE FRICTION COURSE:

407-3.03 Bituminous Material: of the Standard Specifications is modified to add:

Approximately 6.0 percent asphalt of type AC-20 will be required; however, the exact amount will be specified by the Engineer.

407-12 Basis of payment: of the Standard Specifications is modified to add:

The bidding schedule quantity of asphaltic concrete is based on estimated spread rate of 59 lbs. per square yard; however, the exact spread rate will be determined by the Engineer.

(RECAC408, 452/Z, 04/14/89)

SECTION 408 - RECYCLED ASPHALTIC CONCRETE: of the Standard Specifications is revised to read:

408-1 Description:

The work under this section shall consist of furnishing all materials, mixing at a plant, hauling, and placing a mixture of new mineral aggregate material and salvaged pavement material together with bituminous material, and mineral admixture if necessary, to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of these specifications.

When the term "asphaltic concrete" is used hereinafter, it shall be deemed to mean asphaltic concrete which is a mixture of new mineral aggregate, salvaged pavement material, bituminous material, and if necessary, mineral admixture.

408-2 Asphaltic Concrete Mix Design Criteria:

Mix designs will be performed in accordance with ARIZ Test Method 815, modified as necessary for recycled asphaltic concrete. Mix designs will be developed on the basis of and tested in accordance with the following test methods:

Criteria	Requirements	Ariz. Test Method
Effective Voids, Percent, Range for mix design only	6.0±1.0	416, Section 9
Index of Retained Strength, Percent, Minimum	50.0	802
Wet Strength, psi, Minimum	150	802
Stability, Pounds, Minimum	2000	815
Flow, 0.01 Inches, Range	8-16	815

NOTE: Preliminary testing done by the department indicate that pugmill mixing of the combined mineral aggregate with lime and 3-5% water prior to entry into the dryer drum may be required to meet the retained strength requirement. The department reserves the right to direct this pugmill mixing, should it be required, in order to meet the retained strength requirement. No additional payment will be made for pugmill mixing should it be required.

408-3 Materials:

408-3.01 Preliminary Sampling and Testing; Tentative Approval of Source:

There is no Department-furnished source of new mineral aggregate material. The contractor shall provide a source in accordance with the requirements of Section 1001.

When the contractor selects a source, he shall notify the Engineer. The Engineer shall be satisfied that the source has been adequately investigated and that samples to be taken will be representative of the material to be used. The Engineer will witness samples taken by the contractor. Samples shall be at least 300 pounds. A representative portion of the coarse material will be tested for loss on abrasion in accordance with the requirements of AASHTO T 96 and shall meet the following requirements:

Maximum loss of 9 percent at 100 revolutions.

Maximum loss of 40 percent at 500 revolutions.

If the material meets the requirements for loss on abrasion, the source will be approved to that extent and acceptable for the development of a trial mix design.

408-3.02 Mineral Aggregate:

Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert materials with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine mineral aggregate or blend material shall consist of natural sand or of sand prepared from rock, or other approved inert materials, or a combination thereof, conforming to the requirements of these specifications.

408-3.03 . Mineral Admixture:

If the mix design requires a mineral admixture, approximately one percent, by weight, of the combined mineral aggregate and salvaged pavement material shall be used. Mineral admixture shall be either portland cement or lime conforming to the following:

Material	Requirement
Portland Cement, Type I or II	ASTM C 150
Portland Cement, Type IP	ASTM C 595
Lime, Type N or S	ASTM C 207

408-3.04 Bituminous Material:

Bituminous material shall conform to the requirements of Section 1005. The type of bituminous material shall be AC-20. Approximately 3.2 percent by weight of the total mix will be required; however, the exact amount will be specified by the Engineer.

408-3.05 Mineral Aggregate; Stockpile Gradation and Quality Characteristics:

Mineral aggregate shall be separated into at least three stockpiles. The Engineer may approve the use of more than three stockpiles or approve changes to the specified stockpile gradations, provided he determines that a suitable composite gradation is obtainable. If more than three stockpiles are utilized, the grading of each stockpile will be specified by the Engineer. If mineral aggregate is separated into 3 stockpiles. The gradation of each stockpile shall be as follows:

	Sieve Size	Percent Passing
Coarse	1 inch	100
	3/4 inch	75 - 100
	3/8 inch	0 - 20
	No. 200	0 - 2.0

Intermediate	1/2 inch	100
	3/8 inch	80 - 100
	1/4 inch	40 - 80
	No. 8	0 - 20
	No. 200	0 - 3.0
Fine	1/4 inch	100
	No. 8	80 - 100
	No. 40	15 - 35
	No. 200	0 - 4.0*

*In order to meet this gradation, washing of the fine material may be required.

Mineral aggregate composited from the stockpiles in the mix design percentages shall be such that the sand equivalent is at least 55 when tested in accordance with the requirements of AASHTO T 176 and the percent of crushed faces is at least 30 when tested in accordance with the requirements of Arizona Test Method 212.

408-3.06 Salvaged Pavement Material; Stockpile Gradation:

Cores from the existing pavement will be taken and information based on the testing of these cores in the laboratory may be obtained from ADOT Materials Testing Services, 1745 West Madison Street, Phoenix, Arizona 85007.

The existing pavement material shall be removed and processed through a mechanical crusher, in such a manner that all of the material will pass the maximum sieve size specified below and there will be a minimum amount of fines. The Engineer reserves the right to waste obviously defective salvaged material or salvaged material that is not representative of the material used in the mix design. Unless otherwise shown on the plans or specified in the special provisions, material developed from milling ramps, crossroads, or other unrepresentative materials will be stockpiled separately by the contractor and not used in the recycled asphaltic concrete. All salvaged material not designated to be wasted or separated by the Engineer will be uniformly and continuously processed and separated into two stockpiles as follows:

Coarse

Sieve Size	Percent Passing
1 1/2 inch	100
3/8 inch	0- 25

Fine

Sieve Size	Percent Passing
3/4 inch	100
3/8 inch	75-100

The material will be tested in accordance with the requirements of Arizona Test Method 240.

408-3.07 Mineral Aggregate and Salvaged Pavement Material Stockpile:

On the basis of samples of material from cores taken in the existing pavement structure, the proportions of mineral aggregate material from each stockpile and the proportion of salvaged material necessary to provide a mixture which is expected to meet the design criteria shall be as follows:

Virgin Mineral Aggregate	Percent
Coarse	18
Intermediate	16
Fine	36
Salvaged Pavement Material	
Coarse and Fine	30

The recycle salvaged pavement Asphaltic Concrete material to be used in the new recycled asphaltic concrete material shall come only from the mainline Milepost 151.15 to Milepost 160.87.

For comparative purposes, quantities shown in the bidding schedule have been calculated based on the following Data:

	Recycled Asphaltic Concrete
Unit Weight, Pounds Per Cubic Foot	142

The exact percentage of material from each stockpile will depend upon the actual gradation of the new mineral aggregate in each stockpile and may vary from the amount indicated by as much as 10 percentage points. No additional payment will be made for changes in proportional use of mineral aggregate stockpiles within 10 percentage points of the targets specified.

The Engineer may direct a reduction in the percentage of salvaged pavement material used in order to obtain the specified design criteria or to obtain an acceptable gradation for the asphaltic concrete. The contractor will be reimbursed for the costs of additional mineral aggregate required in the asphaltic concrete should the percentage use of salvaged pavement material be reduced from the target specified.

408-4 Mix Design

408-4.01 Trial Mix Design:

At least 15 working days prior to the production of asphaltic concrete, samples of the produced mineral aggregate stockpiles, including any blend material, shall be obtained by the contractor and witnessed by the Engineer so that both parties are satisfied that samples are representative of the mineral aggregates to be utilized in recycled asphaltic concrete production. The contractor shall furnish the Engineer with samples of at least 150 pounds of mineral aggregate from each stockpile and samples of the bituminous material to be utilized in the production of recycled asphaltic concrete. Accompanying the samples shall be a letter from the contractor detailing the source of asphalt cement; and the type and source of mineral admixture to be used, if required, and the method of adding it.

From the mineral aggregate samples furnished by the contractor and samples of existing pavement material taken by the Engineer, the Engineer will determine if asphaltic concrete meeting the specified mix design criteria can be produced.

The trial mix design will specify a composite mineral aggregate gradation; a single percentage to be used from each of the stockpiles of mineral aggregate, a single percentage of salvaged pavement material from the combined use of both salvaged pavement stockpiles, and the percent of bituminous material and mineral admixture, if necessary, to be used. The anticipated gradation of the combined materials and the percent of bituminous material will also be specified. If a mineral admixture is necessary, both the composite mineral aggregate gradation and the anticipated gradation of the combined materials will include the mineral admixture.

408-4.02 Initial Mix Design:

During the first full shift of asphaltic concrete production, the Engineer will test the material for Effective Voids, Stability, and Flow. Samples will also be tested for conformity with the anticipated gradation of the combined materials and the percent of bituminous material in accordance with the requirements of Arizona Test Method 402.

Asphaltic concrete will be considered satisfactory and production may continue if the mix design criteria for flow and stability have been met, the effective voids of the mix is between 3.0% and 7.0%, the percent of bituminous material, based on the average of three consecutive tests, does not vary more than 0.60 from the anticipated extraction target, and the gradation, based on the average of three consecutive tests, does not vary from the trial mix targets as follows:

Passing Sieve	Allowable Limit
No. 8	±6
No. 40	±6
No. 200	±2.0

If the mixture meets these criteria, the trial mix design will be deemed to be the approved initial mix design. If the mix design criteria are not met or if the gradations vary more than the allowable limits, the Engineer reserves the right to stop the work for a period of two working days to perform additional testing. The Engineer will then furnish the contractor with a new mix design which will be deemed to be the approved initial mix design. During the time that the recycled asphaltic concrete operation is stopped, asphaltic concrete meeting the requirements of section 406 may be produced. Delays caused by this work stoppage are not compensable.

The approved initial mix design will specify a composite mineral aggregate gradation, a single percentage to be used from each of the stockpiles of mineral aggregate, the percent of bituminous material and mineral admixture, if necessary, to be used. The anticipated gradation and the percent of bituminous material of the combined materials will also be specified. If a mineral admixture is necessary, both the composite mineral aggregate gradation and the anticipated gradation of the combined materials will include the mineral admixture. A single percentage of salvaged pavement material will be specified in the initial mix design, the actual percentage use of each of the salvaged stockpiles will be determined by the Engineer on the basis of the relative weight of salvaged material produced for each stockpile.

408-5 Changes in Initial Mix Design During Production:

During the production of asphaltic concrete, the Engineer may order that changes be made in the approved initial mix design to meet the mix design criteria. The percent of material used from any one aggregate stockpile or the total percent of salvage material will not change more than five percentage points from the initial mix design.

Once an initial mix design has been approved by the Engineer, the costs associated with testing additional recycled mix design proposals requested by the contractor shall be borne by the contractor.

408-6 Acceptance of Materials:

408-6.01 General:

The contractor's attention is directed to the requirements of Subsection 105.12 - Removal of Unacceptable and Unauthorized Work.

408-6.02 Mineral Aggregate:

At the direction of and witnessed by an authorized representative of the Engineer, the contractor shall secure one representative sample of each days production from each stockpile. This sample will be composited to the specified stockpile percentages by the Engineer. The sand equivalent shall be a minimum of 55 when tested in accordance with the requirements of AASHTO T 176 and the percent of crushed faces shall be at least 30 when tested in accordance with the requirements of Arizona Test Method 212.

The stockpiled material will not be acceptable if clay balls, coated rock, or other deleterious material are present.

For each approximate 1,000 tons of asphaltic concrete produced at least one sample of mineral aggregate will be taken. Samples will be taken in accordance with the requirements of Arizona Test Method 105 on a random basis just prior to the addition of bituminous material and prior to the combining with the salvaged material. Samples will be taken by means of a sampling device which is capable of obtaining samples which are representative of the mineral aggregate. The device, which shall be approved by the Engineer, shall be furnished by the contractor. In any shift that the production of asphaltic concrete is less than 1,000 tons, at least one sample will be taken.

Samples will be tested for conformance with the mineral aggregate gradation in accordance with the requirements of Arizona Test Method 201. When mineral admixture is required, gradation results will be adjusted to reflect this addition. The gradation of the mineral aggregate will be considered to be acceptable unless the average of any three consecutive tests or the result of any single test varies from the mix design gradation percentages as follows:

Passing Sieve	Number of Tests 3 Consecutive	One
3/8 inch and larger	±6	±8
No. 8	±4	±6
No. 40	±4	±6
No. 200	±1.5	±2.0

One hundred percent of the material shall pass the largest sieve size shown in the stockpile gradings.

Salvaged pavement material shall be separated and stockpiled as described in Subsection 408-3.06 so that segregation is minimized. An approved divider of sufficient size to prevent intermingling of stockpiles shall be provided. The belts to the coarse and fine stockpiles shall either have weight totalizers to give proportioning information on the quantity of material from each stockpile or the contractor shall provide an alternate method approved by the Engineer to provide proportioning information.

408-7.03 Proportioning:

The contractor shall provide documentation by calibration charts or other approved means that the mineral aggregate, salvaged pavement material, bituminous material, and mineral admixture, if used, are being proportioned in accordance with the approved mix design.

If a mineral admixture is necessary to produce asphaltic concrete that meets the design criteria, the mineral admixture shall be thoroughly mixed either with the mineral aggregate or with the bituminous material prior to combining the mineral aggregate, salvaged pavement material and bituminous material, at the option of the contractor.

If the mineral admixture is added to the mineral aggregate, it may be necessary to apply a light spray of water to control the loss of the mineral admixture. If a drum drier is used, the mineral admixture shall be added and thoroughly mixed by means of a mechanical mixing device prior to the mixture entering the drum drier. If either a batch plant or a continuous plant is used, the mineral admixture shall be added and thoroughly mixed in the pugmill prior to adding the bituminous material.

If the mineral admixture is added to the bituminous material, it shall be added and thoroughly mixed by means of an approved mixing device that produces a homogeneous mixture prior to the mixture being combined with the mineral aggregate and salvaged pavement material.

If a mineral admixture is used, a positive signal system and a limit switch device shall be installed in the plant at the point of introduction of the admixture. The positive signal system shall be placed between the metering device and the drum dryer, and utilized during production whereby the mixing shall automatically be stopped if the admixture is not being introduced into the mixture.

No fine material which has been collected in the dust collection system shall be returned to the mixture unless the Engineer, on the basis of tests, determines that all or a portion of the collected fines can be utilized. If the Engineer so determines, he will authorize in writing the utilization of a specific proportion of the fines; however, authorization will not be granted unless the collected fines are accurately and uniformly metered into the mixture.

At any time that test results indicate that the gradation of the mineral aggregate does not fall within all of the limits indicated, the production of asphaltic concrete shall cease immediately and shall not begin until calibration tests indicate that the gradation is within the limits indicated.

408-6.03 Bituminous Material Content:

The contractor shall provide an accurate method of determining the actual amount of bituminous material being incorporated into the mix. Production of asphaltic concrete shall not commence until calibration tests indicate that the method utilized is accurate. The Engineer may require recalibration of the bituminous delivery system at any time or when the results of the average of three consecutive extraction tests indicate a variation from the anticipated combined bituminous content by more than 0.60 percent.

408-6.04 Salvaged Pavement Material:

At the direction of and witnessed by an authorized representative of the Engineer, the contractor shall secure a representative sample of each day's production from each stockpile. This sample will be tested by the Engineer.

If the material does not conform to the specified stockpile grading, production of salvaged material stockpiles will cease until the contractor has corrected his stockpiling operations.

408-7 Construction Requirements:

408-7.01 Quality Control:

Quality control shall be the responsibility of the contractor. The Engineer reserves the right to obtain samples of any portion of any material at any point of the operations for his own use.

408-7.02 Stockpiling:

When the total quantity of asphaltic concrete required can be produced in two successive eight hour shifts or less, sufficient mineral aggregate shall be stockpiled at the site of the hot plant to produce the quantity of asphaltic concrete required.

When the total quantity of asphaltic concrete required must be produced in more than two successive eight hour shifts, sufficient mineral aggregate shall be stockpiled at the site of the hot plant for at least one eight hour shift of asphaltic concrete production; however, these requirements will be modified during the last two days production, or under special conditions with the Engineer's approval.

Mineral aggregate shall be separated and stockpiled so that segregation is minimized. An approved divider of sufficient size to prevent intermingling of stockpiles shall be provided.

Mineral aggregate, salvaged pavement material, mineral admixture, and bituminous material shall be proportioned by weight, or by a combination of volume and weight.

When mineral aggregate, salvaged pavement material, mineral admixture, and bituminous material are proportioned by weight, all boxes, hoppers, buckets or similar receptacles used for weighing materials, together with scales of any kind used in batching materials, shall be insulated against the vibration or movement of the rest of the plant due to the operation of any equipment so that the error in weighing with the entire plant operating shall not exceed two percent for any setting nor one and one-half percent for any batch. Bituminous material shall be weighed in a heated, insulated bucket suspended from a springless dial scale system.

When mineral aggregate, salvaged pavement material, mineral admixture, and bituminous material are proportioned by volume, the correct portion of each mineral aggregate size and salvaged pavement material introduced into the mixture shall be drawn from the storage bins by an approved type of continuous feeder which will supply the correct amount of mineral aggregate and salvaged pavement material in proportion to the bituminous material and so arranged that the proportion of each mineral aggregate size and salvaged pavement material can be separately adjusted. The continuous feeder for the mineral aggregate and salvaged pavement material shall be mechanically or electrically actuated.

408-7.04 Drying and Heating:

A recording pyrometer or other approved recording thermometric instrument sensitive to a rate of temperature change of not less than ten degrees F. per minute shall be so placed at the discharge chute of the drier in order to record automatically the temperature of the asphaltic concrete or mineral aggregate and to facilitate reading the recorded temperature. A copy of the recording shall be given to the Engineer.

The moisture content of the asphaltic concrete immediately behind the paver shall not exceed one percent. The moisture content will be determined in accordance with the requirements of Arizona Test Method 406. Drying and heating shall be accomplished in such a manner as to preclude the mineral aggregate from becoming coated with fuel oil or carbon.

408-7.05 Mixing:

The production of the plant shall be governed by the rate required to obtain a thorough and uniform mixture of the materials. Mixing shall continue until the uniformity of coating is as high as can reasonably be achieved considering the character of the mixture.

A positive signal system shall be provided to indicate the low level of mineral aggregate and salvaged pavement material in the bins. The plant will not be permitted to operate unless this signal system is in good working condition. Each bin shall have an overflow chute or a divider to prevent material from spilling into adjacent bins.

The temperature of asphaltic concrete upon discharge from the mixer shall not exceed 325 degrees F. If the asphaltic concrete is discharged from the mixer into a hopper, the hopper shall be constructed so that segregation of the asphaltic concrete will be minimized.

408-7.06 Placing and Finishing:

(A) General Requirements:

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

All wheels and tires of compactors and other equipment shall be wiped when necessary with an approved product in order to prevent the picking up of the asphaltic concrete.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of objectionable material.

A light coat of bituminous material shall be applied as directed to edges or vertical surfaces against which asphaltic concrete is to be placed.

The base or subgrade upon which the asphaltic concrete is to be placed shall be prepared in accordance with the applicable requirements for the material involved and maintained in a smooth and firm condition until placement. Asphaltic concrete shall not be placed on a frozen or excessively wet base or subgrade.

Asphaltic concrete placed in nominal thicknesses of one and one-half inches or less shall be placed only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 65 degrees F. Nominal thicknesses greater than one and one-half inches shall be placed only when the ambient temperature is at least 45 degrees F. and rising and placement shall be stopped when the ambient temperature is 50 degrees F. and falling.

At any time the Engineer may require that the work cease or that the work day be reduced in the event of weather conditions either existing or expected which would have an adverse effect upon the asphaltic concrete.

All asphaltic concrete shall be placed either as a leveling course or as a surfacing course. Leveling courses are defined as courses placed for the primary purpose of raising an existing paved or unpaved surface to a smooth plane. Surfacing courses are defined as courses placed to serve either as the traffic surface or as a surface upon which a finishing course or seal coat is to be placed.

The thickness of leveling and surfacing courses will be shown on the project plans. No change in thickness will be allowed without the written approval of the Engineer.

Succeeding lifts of asphaltic concrete shall not be placed on any asphaltic concrete that has not been accepted by the Engineer.

(B) Loading Asphaltic Concrete into the Paving Machine:

If the asphaltic concrete is dumped from the hauling vehicles directly into the paving machine, care shall be taken to avoid jarring the machine or moving it out of alignment. No vertical load shall be exerted on the paving machines by the trucks. Trucks, while dumping, shall be securely attached to the paving machine.

If the asphaltic concrete is dumped upon the surface being paved and subsequently loaded into the paving machine, it shall not be dumped at a distance greater than 150 feet in front of the paving machine. The loading equipment shall be self-supporting and shall not exert any vertical load on the paving machine. Substantially all of the asphaltic concrete shall be picked up and loaded into the paving machine.

(C) Placing and Finishing Asphaltic Concrete by Means of Self-Propelled Paving Machines:

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impracticable.

In order to achieve, as far as practicable, a continuous operation, the speed of the paving machine shall be coordinated with the production of the plant.

Self-propelled paving machines shall spread the mixture without segregation or tearing within the specified tolerances, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which will distribute the mixture uniformly in front of adjustable screeds.

Screeds shall include any strike-off device operated by tamping or vibrating action which is effective without tearing, shoving or gouging the mixture and which produces a course with a uniform texture and density for the full width being paved. Screeds shall be adjustable as to height and crown and shall be equipped with a controlled heating device for use when required.

Tapered sections not exceeding eight feet in width, or widened sections not exceeding four feet in width may be placed and finished by other means approved by the Engineer.

(D) Automatically Actuated Control System:

Except under certain conditions or at certain locations where the Engineer deems the use of automatic controls impracticable, all courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines equipped with an automatically actuated control system.

The control system shall control the elevation of the screed at each end by controlling the elevation of one end directly and the other end indirectly either through controlling the transverse slope or alternately when directed, by controlling the elevation of each end independently.

The control system shall be capable of working with the following devices which shall be furnished with the machine:

Ski-type device at least 30 feet in length, supported throughout its entire length.

Short ski.

500 feet of control line and stakes.

Joint matcher shoe.

The control line shall be set and maintained taut by the contractor to the grade and alignment established by the Engineer.

Failure of the control system to function properly shall be cause for the suspension of the asphaltic concrete operations.

408-7.07 Joints:

Longitudinal joints shall be located within one foot of the center of a lane or within one foot of the center line between two adjacent lanes. Joints shall be formed by a slope shoe or hot lapped, and shall result in a smooth uniform surface.

Before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth and exposing a fresh face. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

408-7.08 Compaction:

(A) Courses One and One-half Inches or Less in Nominal Thickness:

(1) General Requirements:

Asphaltic concrete immediately behind the laydown machine shall be a minimum of 275 degrees F.

(2) Equipment:

Compacting and smoothing shall be accomplished by the use of self-propelled equipment. Compactors shall be pneumatic tired and steel wheel and shall be approved by the Engineer.

Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

Steel wheel compactors shall weigh not less than eight tons.

Pneumatic tired compactors shall be the oscillating type with at least seven pneumatic tires of equal size and diameter. Wobble-wheel compactors will not be permitted. The tires shall be spaced so that the gaps between adjacent tires will be covered by the following tires. The tires shall be capable of being inflated to 90 pounds per square inch and maintained so that the air pressure will not vary more than five pounds per square inch from the designated pressure. Pneumatic tired compactors shall be constructed so that the total weight of the compactor will be varied to produce an operating weight per tire of not less than 5,000 pounds. Pneumatic tired compactors shall be equipped with skirt-type devices mounted around the tires so that the temperature of the tires will be maintained during the compaction process.

(3) Rolling Method Procedure:

Compaction shall consist of an established sequence of coverages using specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used and the number of coverages required shall be as follows:

	Type of Compactor		No. of coverages	
Rolling Sequence	Option No. 1	Option No. 2	Option No. 1	Option No. 2
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	2-6*	2-4*
Finish	Static Steel	Static Steel	1-3	1-3

*Based on the roller pattern which exhibits the best performance.

The Engineer shall select the option for compaction, and when pneumatic tired compactors are used, will designate the tire pressure.

Steel wheel compactors shall not be used in the vibratory mode for courses of one inch or less in nominal thickness nor when the temperature of the asphaltic concrete falls below 180 degrees F.

Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 220 degrees F. All edges shall be rolled by a method approved by the Engineer while the mixture is still hot.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors ballasted and operated as specified and with the number of coverages of the compactors as specified.

(B) Courses Greater Than One and One-half Inches in Nominal Thickness:

(1) General:

Asphaltic Concrete immediately behind the laydown machine shall be a minimum of 275 degrees F.

Compaction shall be as specified in this Subsection except that if the Engineer determines the conditions of any portion of the paving, such as widenings, intersections, tapers and turnouts, not to be conducive to the procedures of this subsection, Subsection 408-7.08(A) will apply.

Asphaltic concrete placed in nominal thicknesses greater than one and one-half inches shall be compacted until 80 percent of the lot, measured as hereinafter specified, is within the Upper and Lower Limits specified. Compaction control shall be the responsibility of the contractor. Selection of the number and types of rollers sufficient to meet the specified density requirements shall be the responsibility of the contractor. The contractor shall monitor his compaction compliance through testing of density and comparison to laboratory compacted specimens. Records of density testing, comparisons to laboratory density, and necessary adjustments to compaction operations shall be maintained. This requirement shall in no way relieve the contractor of the responsibility to provide an acceptable product as set forth elsewhere in the specifications.

(2) Compaction Acceptance Procedure:

A lot shall consist of one days production. Each lot will be tested for acceptance. If changes are made in the mix design, new lots will be established.

Ten samples shall be taken for each lot by the contractor, under the observation of the Engineer, at random locations designated by the Engineer. Randomly selected locations will be determined to the nearest one-half (1/2) foot in the transverse direction and to the nearest one (1) foot in the longitudinal direction of the pavement course; however, the outside one (1) foot of an unconfined pavement course will be excluded from the testing. When a previously unconfined pavement course is confined by a subsequent pavement course, the compacted joint will not be excluded from the testing. Samples shall be taken utilizing mechanical coring equipment in accordance with the requirements of Arizona Test Method 104, Section 3. Cores shall be a minimum of four inches in diameter and shall be taken and delivered to the Engineer not later than the working day following the lot placement. The samples will be tested for acceptance by the Engineer in accordance with the requirements of Arizona Test Method 415. Acceptance testing results will be furnished to the contractor within three working days of receipt of all samples by the Engineer.

The target value (TV) for compaction compliance shall be 98.0 percent of laboratory density. The laboratory density shall be the average of three (3) laboratory densities determined on random samples taken from the same day's production and in accordance with the requirements of Arizona Test Method 416.

The Upper Limit (UL) is the Target Value (TV) plus 4.5 pounds per cubic foot and the Lower Limit (LL) is the Target Value (TV) minus 4.5 pounds per cubic foot. These limits are used in statistical calculations for Quality Index. The Engineer will determine the acceptability of compaction utilizing the following definitions, formulas, and Table 408-1.

DEFINITIONS, ABBREVIATIONS AND FORMULAS FOR COMPACTION ACCEPTANCE

Target Value (TV):

The target value for compaction.

Average (AVE.):

The sum of the lot's test results for a measured characteristic divided by the number of test results; the arithmetic mean. The average will be determined to one decimal place.

Standard Deviation (s):

The square root of the value formed by summing the squared difference between the individual test results of a measured characteristic and AVE., divided by the number of test results minus one. This statement does not limit the methods of calculations. Other methods which obtain the same value may be used. The standard deviation will be determined to two decimal places.

Upper Limit (UL):

The value above the target value for compaction which defines the upper limit of acceptable compaction.

Lower Limit (LL):

The value below the target value of compaction which defines the lower limit of acceptable compaction.

Upper Quality Index (QU):

$$QU = \frac{UL - AVE}{s}$$

The QU will be calculated to three decimal places.

Lower Quality Index (QL):

$$QL = \frac{AVE - LL}{s}$$

The QL will be calculated to three decimal places.

Percentage of Lot within UL (PU):

Determined by entering Table 408-1 with QU.

Percentage of Lot within LL (PL):

Determined by entering Table 408-1 with QL.

Total Percentage of Lot Within UL and LL (PT):

PT = (PU + PL) - 100

Should the contractor fail to meet the specified density requirements for more than two lots, work shall cease until the contractor has examined all aspects of his compaction procedures and implemented all corrective actions necessary to obtain compaction. Work may resume for one shift of production during which time the contractor will demonstrate his ability to meet the compaction requirements. In the event the contractor fails to meet the compaction requirements during this one shift of production, the work shall again cease. At that time the Engineer will evaluate the specified compaction requirements. For purposes of evaluation, the Engineer may require the construction of a compaction test section. The test section will consist of not more than one day's production during which the Engineer will direct the compaction operations, including the size, type, sequencing and number of passes of each roller, the mix temperature, and the rate of production. Based upon his evaluation of the compaction requirements, the Engineer will determine if the specified compaction requirements are attainable. Should the Engineer determine that the specified requirements are not attainable, revised requirements will be established which set forth a new target value and/or percent of lot compliance. The contractor will proceed on the basis of the Engineer's determination. Material which fails to meet the requirements for compaction will be evaluated in accordance with subsection 105.03. No additional payment will be made for the costs associated with the procedures set forth herein, including the construction of test sections.

408-7.09 Compacting Miscellaneous Items and Surfaces:

Asphaltic concrete used in the construction of curbs, spillways and spillway inlets, ditches, catch basin entrances, median strips, sidewalks or other similar miscellaneous items or surfaces shall be compacted using compactors, hot hand tampers, smoothing irons, mechanical vibrating hand tampers or with other devices to the extent considered necessary by the Engineer.

408-7.10 Surface Requirements and Tolerances:

All courses of asphaltic concrete shall be compacted as required, smooth and reasonably true to the required lines, grades, and dimensions.

Leveling course surfaces shall not vary more than 1/4 inch from the lower edge of a ten-foot straightedge when the straightedge is placed parallel to the center line of the roadway.

Surfacing course surfaces shall not vary more than 1/8 inch from the lower edge of a ten-foot straightedge when the straightedge is placed parallel to the center line of the roadway.

408-8 Method of Measurement:

Asphaltic concrete will be measured by the ton for the asphaltic concrete actually used, which will include the weight of mineral aggregate, salvaged pavement material, bituminous material, and any necessary mineral admixture. Measurement will include any tonnage used in construction of intersections, turnouts, curbs, spillways and spillway inlets, ditches, catch basin entrances, median strips, sidewalks or other miscellaneous items or surfaces.

Bituminous material will be measured by the ton.

Mineral admixture will be measured by the ton.

408-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided in Subsection 408-8, will be paid for at the contract unit price complete in place.

Payment for bituminous material will be made by the ton. If it is determined by testing that bituminous material utilized in the asphaltic concrete production fails to meet the requirements of Section 1005, the asphaltic concrete represented by the half-shift or half-shifts in which such failing material was utilized, shall be evaluated as to acceptance. When such failure involves a deviation from the allowable asphalt property range, the contract unit price will be adjusted by the percentage shown in Table 404-1 of the Standard Specifications, when allowed to remain in place. When the failure or failures is (are) due to deviations from other requirements, the Engineer will determine if the material can be left in place, and, if so allowed, the appropriate unit price adjustment will be made. Asphaltic concrete not allowed to remain in place will be rejected and removed at the contractor's expense and replaced with asphaltic concrete meeting the requirements of these specifications.

If mineral admixture is used in the mix design it will be paid for at the predetermined price established in the Bidding Schedule. If mineral Admixture is eliminated, it will be eliminated in accordance with the requirements of Subsection 109.05, however, no reimbursement will be made for any costs which the contractor may have incurred in anticipation of its use.

TABLE 408-1
DETERMINATION OF PU OR PL
N=10

QU or QL>0		QU or QL<0
100.	2.176 or More	0.
99.	1.940 - 2.175	1.
98.	1.798 - 1.939	2.
97.	1.691 - 1.797	3.
96.	1.603 - 1.690	4.
95.	1.526 - 1.602	5.
94.	1.458 - 1.525	6.
93.	1.396 - 1.457	7.
92.	1.339 - 1.395	8.
91.	1.286 - 1.338	9.
90.	1.236 - 1.285	10.
89.	1.188 - 1.235	11.
88.	1.143 - 1.187	12.
87.	1.100 - 1.142	13.
86.	1.058 - 1.099	14.
85.	1.018 - 1.057	15.
84.	0.980 - 1.017	16.
83.	0.942 - 0.979	17.
82.	0.906 - 0.941	18.
81.	0.871 - 0.905	19.
80.	0.836 - 0.870	20.
79.	0.802 - 0.835	21.
78.	0.769 - 0.801	22.
77.	0.737 - 0.768	23.
76.	0.705 - 0.736	24.
75.	0.674 - 0.704	25.
74.	0.643 - 0.673	26.
73.	0.613 - 0.642	27.
72.	0.583 - 0.612	28.
71.	0.554 - 0.582	29.
70.	0.525 - 0.553	30.
69.	0.496 - 0.524	31.
68.	0.468 - 0.495	32.
67.	0.440 - 0.467	33.
66.	0.412 - 0.439	34.
65.	0.384 - 0.411	35.
64.	0.357 - 0.383	36.
63.	0.330 - 0.356	37.
62.	0.303 - 0.329	38.
61.	0.276 - 0.302	39.
60.	0.249 - 0.275	40.
59.	0.223 - 0.248	41.
58.	0.196 - 0.222	42.
57.	0.170 - 0.195	43.
56.	0.143 - 0.169	44.
55.	0.117 - 0.142	45.
54.	0.091 - 0.116	46.
53.	0.065 - 0.090	47.
52.	0.039 - 0.064	48.
51.	0.013 - 0.038	49.
50.	0.000 - 0.012	50.

N = NUMBER OF TESTS PER LOT
BODY OF TABLE IS POSITIVE OR NEGATIVE VALUES OF QU OR QL

(ACEX416, 453/0, 05/31/89)

SECTION 416 - ASPHALTIC CONCRETE - END PRODUCT:

416.1 Description: of the Standard Specifications is modified to add:

The quantities shown in the bidding schedule for item 4160002 - "ASPHALTIC CONCRETE (3/4"Mix)(End Product)," includes 2,000 Tons of asphaltic concrete (3/4" Mix)(End Product) to be used in the first day the contractor starts milling the existing roadway pavement, and to allow an adequate amount of recycled pavement material to be available to commence production of recycled asphaltic concrete.

416-2 Asphaltic Concrete Mix Design Criteria: of the Standard Specifications is modified to add:

Mix design criteria for the Index of Retained Strength and applicable test method shall be as follows:

Criteria	Requirements 3/4" Mix	Arizona Test Method
4. Index of Retained Strength, Percent, Min.	50	802

416-2 Asphaltic Concrete Mix Design Criteria: mix design criteria for effective voids in the Standard Specifications is revised to read:

Criteria	Requirements 3/4" Mix	Arizona Test Method
2. Effective Voids Percent, Range	5.5 ± 0.2	815

416-3.01 Mineral Aggregate: of the Standard Specifications is modified to add:

Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods.

Mineral Aggregate Characteristics	Test Method	Requirement
Combined Bulk Specific Gravity	AASHTO T 85, Arizona Test Method 211	2.35 to 2.85

(ACEX416, 453/0, 05/31/89)

SECTION 416 - ASPHALTIC CONCRETE - END PRODUCT:

416.1 Description: of the Standard Specifications is modified to add:

The quantities shown in the bidding schedule for item 4160002 - "ASPHALTIC CONCRETE (3/4"Mix)(End Product)," includes 2,000 Tons of asphaltic concrete (3/4" Mix)(End Product) to be used in the first day the contractor starts milling the existing roadway pavement, and to allow an adequate amount of recycled pavement material to be available to commence production of recycled asphaltic concrete.

416-2 Asphaltic Concrete Mix Design Criteria: of the Standard Specifications is modified to add:

Mix design criteria for the Index of Retained Strength and applicable test method shall be as follows:

Criteria	Requirements 3/4" Mix	Arizona Test Method
4. Index of Retained Strength, Percent, Min.	50	802

416-2 Asphaltic Concrete Mix Design Criteria: mix design criteria for effective voids in the Standard Specifications is revised to read:

Criteria	Requirements 3/4" Mix	Arizona Test Method
2. Effective Voids Percent, Range	5.5 ± 0.2	815

416-3.01 Mineral Aggregate: of the Standard Specifications is modified to add:

Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods.

Mineral Aggregate Characteristics	Test Method	Requirement
Combined Bulk Specific Gravity	AASHTO T 85, Arizona Test Method 211	2.35 to 2.85

Combined Water Absorption	AASHTO T 85, Arizona Test Method 211	0.0 to 2.5
Sand Equivalent	AASHTO T 176	Minimum 45
Crushed Faces	Arizona Test Method 212	Minimum 30%
Abrasion	AASHTO T 96	100 Rev., Max 9% 500 Rev., Max 40%

Tests on aggregates outlined above, except for abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. Abrasion shall be performed separately on materials from each source of mineral aggregate. All sources shall meet the requirements for abrasion.

For comparative purposes, quantities shown in the bidding schedule have been calculated based on the following data:

	3/4" Mix
Unit Weight, Pounds per Cubic Foot	145.00
Percent, Asphalt Cement	5.0
Percent, Mineral Admixture	2.0

416-3.03 Bituminous Materials: of the Standard Specifications is modified to add:

The grade to be used shall be AC-40

416-4 Mix Design: The last five paragraphs on page 273 of the Standard Specifications are revised to read:

The mix design shall be submitted on a laboratory bituminous mixture design form in ADOT format and signed by a person authorized by the contractor to act in such matters on behalf of the contractor.

Representative samples of the mineral aggregate used for the mix design shall be submitted to the Engineer for determination of a coating index and sand equivalent. The coating index will be determined in accordance with the requirements of Arizona Test Method 239 and the sand equivalent will be determined in accordance with the requirements of AASHTO T-176.

The Engineer will determine the Coating Index and Sand Equivalent and review the mix design to assure that it contains all required information. If the mix design is unsatisfactory or incomplete, the Engineer will, within two working days after receipt of all samples and the mix design proposal, advise the contractor of the need to resubmit the mix design proposal.

If the contractor elects to change his source of material, once a mix design has been approved, or if a mix design should prove unsatisfactory to the contractor during production, the contractor shall furnish the Engineer with a new mix design for approval which meets the requirements specified herein. For acceptance purposes, the revised mix design will not be retroactive.

416-5 Contractor Quality Control: Of the Standard Specifications is revised to read:

416-5.01 General Requirements:

It shall be the responsibility of the contractor to administer a Quality Control Plan, hereinafter referred to as the "Plan", sufficient to assure a product meeting the requirements of these specifications. The Plan shall meet the requirements of Subsection 106.04(B) and the requirements specified below. The Plan may be operated wholly or in part by a subcontractor or an independent organization, however, the Plan's administration, including compliance with the Plan and its modification, shall remain the responsibility of the contractor.

416-5.02 Elements of The Plan:

The Plan shall address all elements which affect the quality of the asphaltic concrete including, but not limited to the following:

(A) Mix Design
(B) Aggregate Production
(C) Quality of Components
(D) Stockpile Management
(E) Proportioning
(F) Mixing, including addition of Mineral Admixture, if required
(G) Placing and Finishing
(H) Joints
(I) Compaction

416-5.03: Other Requirements:

The Plan shall include the use of Operation's Technicians, including the following:

(A) Process Control Technician (PCT). This person will be expected to utilize laboratory test results and other quality control practices to assure the quality of aggregates and other mix components and adjust and control mix proportioning to meet the mix design(s). The Plan shall detail the frequency of each type of test, when and how corrective actions are to be taken, and the means of documentation. The PCT shall be responsible for periodically inspecting all equipment utilized in proportioning and mixing to assure its proper operating condition and to assure that proportioning and mixing is in conformance with the mix design and other requirements. The Plan shall set forth how these duties and responsibilities will be accomplished and documented.

If more than one individual is required to accomplish these requirements, the Plan shall so note. Included also shall be the criteria utilized by the PCT to correct or reject unsatisfactory materials.

(B) Quality Control Technician (QCT). This person will be expected to assure that the delivered materials meet the requirements of the specifications. In addition, this person shall be responsible for periodically inspecting all equipment utilized in placing, finishing and compacting to assure its proper operating condition and to assure placing, finishing, joint construction and compaction in conformance with the specifications. The Plan shall set forth how these duties and responsibilities will be accomplished and documented. If more than one individual is required to accomplish these requirements, the Plan shall so note. Included also shall be the criteria utilized by the QCT to correct or reject unsatisfactory materials.

(C) The Plan shall set forth the coordination of the activities of the PCT and QCT.

(D) The Department reserves the right to check the records of the PCT and QCT at any time. The Department may take and test samples at any time to confirm the effectiveness of the activities of the PCT and QCT.

416-9 Basis of Payment:

(F) Mineral Admixture: of the Standard Specifications is revised to read:

If mineral admixture is used in the mix design it will be paid for at the predetermined price established in the Bidding Schedule. If mineral Admixture is eliminated, it will be eliminated in accordance with the requirements of Subsection 109.05, however, no reimbursement will be made for any costs which the contractor may have incurred in anticipation of its use.

(FORMS601, 454/u, 04/14/89)

SECTION 601 - CONCRETE STRUCTURES:

601-3.02 Falsework and Forms:

601-3.02(C) Forms Construction:

(1) General Requirements: of the Standard Specifications is modified as follows:

The last sentence of the fifth paragraph, regarding re-use of plywood forms, is hereby deleted.

(3) Metal, Fiberglass and Other Forms: of the Standard Specifications is modified as follows:

The fourth paragraph, regarding the use of metal forms, is hereby deleted.

601-3.02(D) Removal of Falsework and Forms: of the Standard Specifications is modified as follows:

The second paragraph on page 333, regarding backfilling around structures, is hereby deleted. Backfilling shall be in conformance with the requirements of Subsection 203-5.03(B).

(DIMT601, 454/g, 06/20/88)

SECTION 601 - CONCRETE STRUCTURES:

601-4.02 Dimensional Tolerances: of the Standard Specifications is modified to add:

(C) Slip Form or Extruded Barrier:

Barrier lengths not in compliance with the straightedge and alignment tolerances in Subsection 601-4.02(C)(2) shall be removed and replaced at the contractor's expense.

(1) The top of the exposed faces of the barrier shall comply with the following tolerances to be accepted at 100 percent of the unit price bid per linear foot.

(a) When a ten foot long straightedge is placed on the top surface of the barrier it shall not vary by more than 1/4 inch from the straightedge.

(b) When a ten foot long straightedge is placed along the face of the barrier it shall not vary by more than 1/2 inch from the straightedge.

(c) The horizontal alignment shall not deviate by more than that allowed in Section 401 when placed adjacent to Portland Cement Concrete Pavement.

All other barrier dimensions shall not deviate by more than 1/2 inch from plan's alignment.

(2) The top and exposed faces of the barrier shall comply with the following tolerances to be accepted at 75 percent of the unit price bid per linear foot.

(a) When a ten foot long straightedge is placed on the top surface of the barrier it shall not vary by more than 1/2 inch from the straightedge.

(b) When a ten foot long straightedge is placed along the face of the barrier it shall not vary by more than 3/4 inch from the straightedge.

(c) The horizontal alignment shall not deviate by more than that allowed in Section 401 when placed adjacent to Portland Cement Concrete Pavement.

All other barrier dimensions shall not deviate by more than 3/4 inch from plan's alignment.

(HSBLT604, 454/f, 04/14/89)

SECTION 604 - STEEL STRUCTURES:

604-2.03 High Strength Bolts, Nuts And Washers: of the Standard Specifications is revised to read:

High Strength Bolts shall conform to ASTM Standard A 325 except as may be modified herein.

Nuts and washers, appropriate to the type of high strength bolt to be used, shall conform to ASTM Standards A 563 or A 194, for nuts, and F 436, for washers, respectively.

604-2.03(A) Certificate Of Analysis:

Each lot of bolts, nuts or washers shall be accompanied by a Certificate of Analysis.

The Certificate Of Analysis shall provide a lot number corresponding to that appearing on the shipping package. The certification shall note when and where all testing was done, including the rotational-capacity tests indicated herein, and shall include zinc thickness when galvanized bolts and nuts are used.

The maximum hardness for ASTM (A 325) bolts shall be $33R_C$. The maximum tensile strength shall be 150ksi for bolts 1" or less in diameter and 120ksi for larger bolts.

Nuts shall be Grade 2H or DH for black or galvanized bolts. For galvanized bolts the nuts shall be overtapped to the minimum amount required for the bolt assembly. All nuts, bolts and washers shall have the manufacturers' markings on them.

Testing to be included in the Certificate of Analysis shall be done according to the "shipping lot" method. The minimum testing required is as follows:

(1) Rotational-Capacity Test:

High strength bolts, both black and galvanized, shall be subjected to a rotational-capacity test (ASTM A 325, Section 8.5) and shall meet the following requirements when tested by the manufacturer:

(a) The tested bolts shall go through two times the required number of turns (from snug tight conditions) indicated in the 1988 Interim AASHTO Bridge Specification, Table 10.17B, in a Skidmore-Wilhelm Calibrator, or equivalent tension measuring device, without stripping or failure.

(b) During this test, the maximum recorded tension shall be equal to or greater than 1.15 times the Required Fastener Tension, as specified in AASHTO Table 10.17A.

(c) The measured torque to produce the Required Fastener Tension shall not exceed the value obtained by the following equation:

Torque = 0.25 PD
Where Torque = Measured Torque (Foot-Pounds)
P = Measured Bolt Tension (Pounds)
D = Nominal Diameter (Feet)

(2) Proof Load And Wedge Tests:

Proof load tests, performed by the manufacturer, are required for the bolts(ASTM A 325, Section 8.2) and for the nuts (ASTM A 563 or ASTM A 194). Wedge tests of full size bolts are required in accordance with Section 8.3 of ASTM A 325. Galvanized bolts shall be wedge tested after galvanizing. The proof load tests for nuts to be used with galvanized bolts shall be performed after galvanizing, overtapping and lubricating.

604-2.03(B) Acceptance Testing:

High-strength bolts, nuts and washers will be field sampled at random by the Engineer, according to the "shipping lot" method, upon receipt of the bolt shipment by the contractor. A minimum of 3 bolts, with corresponding nuts and washers, or 0.1% of the lot, for lots in excess of 3,000, will be sampled for acceptance testing, for each bolt diameter. Samples will be submitted to ADOT Materials Section or a designated testing laboratory for the following tests:

(1) Wedge Test:

Bolts shall be tested in accordance with ASTM Test Method F 606 - WEDGE TEST METHOD as described in Section 3.5 of that standard. Fracture shall be in the body or threads of the bolt without any fracture at the junction of the head and body.

(2) Rockwell Hardness:

Rockwell hardness shall be determined in accordance with ASTM Test Method E 18 within the specified maximum shown above for bolts. Nuts and washers will only be tested for Rockwell hardness, in accordance with ASTM Test Method E 18, to confirm compliance with ASTM Standards A 563 or A 194 for nuts and F 436 for washers.

If any of the test bolts fail either of the above acceptance tests, the entire lot which it represents will be rejected. Similarly, if any of the nuts or washers fail the Rockwell Hardness Test, the entire lot of nuts or washers will be rejected.

604-2.03(C) Installation:

All galvanized nuts shall be lubricated with a lubricant containing a visible dye so that a visual check can be made for the lubricant at the time of field installation. Black bolts must be "oily" to the touch when installed. Weathered or rusted bolts shall be cleaned and re-lubricated prior to installation.

Installation of all high strength bolts shall be in accordance with paragraph 10.17.4, "Installation", of the AASHTO 1988 Interim Bridge Specifications. Of particular importance is obtaining the "Snug tight" condition as defined in paragraph 10.17.4.3 for any method of final tightening.

A Skidmore-Wilhelm Calibrator or other acceptable bolt tension indicating device will be provided by the Department at each job site for use during bolt installation. Periodic tests (daily when calibrated wrench tightening is used) will be performed by the Department to ensure the as-installed bolt/nut/washer assembly meets the above requirements. [For short grip bolts, direct tension indicators (DTI) with solid plates may be used to perform this test. The DTI shall be checked with a longer grip bolt in the Skidmore-Wilhelm Calibrator first].

The cost of furnishing test bolts, nuts and washers will not be directly reimbursed, but will be considered incidental to the cost of related contract items.

(PDMPT701, 453/4, 10/13/89)

SECTION 701 - MAINTENANCE AND PROTECTION OF TRAFFIC:

701-2 Materials(Equipment, Workmen, Devices and Facilities):

701-2.02 Flashing Arrow Panels: the first paragraph of the Standard Specifications is revised to read:

Flashing arrow panels shall conform to the requirements of Section 4.17 of the Traffic Control Manual with the following additions:

701-2.05 Temporary Pavement Markings: is revised to read:

(A) Raised Pavement Markers:

Raised Pavement Markers may be Temporary Reflective Markers, Permanent Reflective Markers(used as Temporary) or Non-reflective Markers, as required on the Project Plans or by the Engineer.

Raised Pavement Markers shall be in conformance with Standard Drawing 4-M-2.02 and Subsections 706-2 and 706-3 of The Specifications or shall be included on a list of pre-approved products maintained by Traffic Design Services.

(B) Pavement Marking Paint:

Paint for temporary striping shall be white or yellow and shall conform to the requirements for permanent striping paint as set forth in Section 708 of the Specifications.

(C) Preformed Pavement Markings:

Preformed Pavement Markings shall be either Type II (Temporary-Removable) or Type III (Temporary-Nonremovable), as indicated on the project plans or as directed by the Engineer. Preformed Pavement Markings shall be in conformance with the requirements of Section 705 of the Specifications or shall be included on a list of pre-approved products maintained by Traffic Design Services.

701-2.08 Chip Seal Pavement Markers: is revised to read:

Chip Seal Pavement Markers shall conform to Standard Drawing 4-M-2.05.

The Chip Seal Marker body and cover shall be manufactured from a polyurethane material conforming to the following requirements:

	Requirement	ASTM Test Method
Specific Gravity (Min.)	1.19	D- 792
Hardness (Min.)	80A	D-2240
Tensile Strength (Min. PSI)	4600	D- 412
Ultimate Elongation (Min.%)	330	D- 412
Modulus @ 300% PSI	1000	D- 412
Stiffness @		
-20 deg. F. (Min. PSI)	17000	D-1053
70 deg. F. (Min. PSI)	900	D-1053
Compression Set		
22 Hrs. @ 70 deg. C.	65	D- 395
Taber Abrasion (CS17 Wheel)		
Wt. loss mg/1000 cycles	3	-------

Reflective tape shall be metalized polycarbonate microprism retroreflective material with acrylic backing or equal. The tape shall have a minimum reflectance equal to, or greater than, 1800 candlepower per foot-candle per square foot at 1/10 degree observation and 0 degree entrance angles.

701-3.02 Maintenance and Protection of Traffic: the first paragraph of the Standard Specifications is modified to add:

The Engineer shall be sole judge as to which signs may require portable stands or embedded posts.

701-3.05 Temporary Pavement Markings (Application and Removal):

701-3.05(A) General: the second paragraph of the Standard Specifications is revised to read:

On overlay projects, pavement marking for temporary striping shall consist of four inch wide by four foot long strips of reflective material, either pavement marking tape or traffic paint, placed at 40 foot intervals. In situations involving severe degree of curvature, the Engineer may direct that the length and spacing be adjusted to two foot and 20 foot respectively. These requirements apply to white lane lines separating traffic moving in the same direction and to yellow centerlines for two-lane, two-way roadways in areas where it is safe to pass. Temporary markings shall not be used for edge striping. Temporary pavement marking shall be placed on each subsequent pavement course.

701-3.05(C) Preformed Pavement Markings: The second paragraph of the Standard Specifications is revised to read:

Only Type II Preformed Pavement Markings shall be used on surface or finish pavement courses where eventual removal will be required by the Traffic Control Plan, or as specified in Subsection 705-3.

701-4.01 General: the first and second paragraphs of the Standard Specifications are revised to read:

The Department will reimburse the contractor for the work of maintaining and protecting traffic on the basis of the predetermined reimbursement rates hereinafter specified under Subsection 701-4.02 for the various elements of work except for Temporary Concrete Barrier, Temporary Impact Attenuation Devices, and Furnish and Install Temporary Traffic Control Devices.

No additional reimbursement will be made to the contractor for any elements of work other than those listed in the special provisions under Subsection 701-4.02, unless approved in writing by the Engineer prior to use. The cost for elements of work required for traffic control and not listed under Subsection 701-4.02, or included in Item 701006, will be negotiated with the Engineer prior to approval.

701-4.02 (B) Elements of Work (Complete-in-Place): of the Standard Specifications is revised to read:

The elements of work listed under this subsection will be measured for payment upon the satisfactory completion of the initial installation or obliteration. Except as hereinafter specified under Basis of Payment, no subsequent measurements will be made.

Element of Work	Unit	Rate($)
Specialty Sign (High Intensity Reflective Sheeting)	Sq. Ft.	10.00
Specialty Sign (Std. Intensity Reflective Sheeting)	Sq. Ft.	7.25
Preformed Pavement Marking (Taped Line) (Type II)	L.Ft.	1.60
Preformed Pavement Marking (Taped Line) (Type III)	L.Ft.	0.80
Temporary Pavement Marking (Painted Line)	L.Ft.	0.13
Obliterate Pavement Marking	L.Ft.	0.50
Obliterate Pavement Legends	Each	10.00
Obliterate Pavement Arrows	Each	20.00
Delineator (Std. Dwg. 4-M-4.01)	Each	27.00
Reflective Raised Pavement Marker (Temporary)	Each	4.00
Reflective Raised Pavement Marker (Permanent) (Used As Temporary)	Each	4.50
Non-Reflective Raised Pavement Marker (Temporary)	Each	2.50
Remove Raised Pavement Marker	Each	0.10
Chip Seal Pavement Marker (Single Capped)	Each	2.00
Chip Seal Pavement Marker (Double Capped)	Each	3.00

701-4.02 (C) Elements of Work (In Use): of the Standard Specifications is revised to read:

The elements of work listed under this subsection will be measured from the point at which the element is put into active use on the project and accepted by the Engineer until such times that the Engineer determines that the element is no longer required:

Element of Work	Unit	Rate($)
Temporary Concrete Barrier(In Use)	L.Ft./Day	0.05
Impact Attenuation Device (Sand Barrel) (In Use)	Ea./Day	0.05
Impact Attenuation Device (Energy Absorbing Terminal)(In Use)	Ea./Day	1.00
Impact Atten Dev. (Truck Mounted)	Hour	27.00
Flashing Arrow Panel	Hour	5.00
Pilot Truck	Hour	6.36

Relocation Service, Truck	Hour		9.00
Flagger	Hour	*Area 1	24.18
		*Area 2	20.20
Flagger (Uniformed Police Officer)	Hour		26.32
Official Police Vehicle	Mile		0.21
Truck Driver: Pilot, Reloc Svcs, Truck Mount Atten. Devices	Hour		15.24
Relocation Service, Barricade Setter	Hour		10.93
Maintain Changeable Message Board	Hour		1.45
Vertical Panels	Ea./Day		0.50
Tubular Marker	Ea./Day		0.35
Barricade (Type II)	Ea./Day		0.50
Barricade (Type III)	Ea./Day		0.75
Flashing Warning Light (Type A)	Ea./Day		0.25
Flashing Warning Light (Type B)	Ea./Day		2.50
Flashing Warning Light (Type C)	Ea./Day		0.80
Steady-Burn Warning Light			
High Intensity Reflective Sheeting, Small Sign (Less than 10 Sq.Ft.)	Ea./Day		1.10
High Intensity Reflective Sheeting, Medium Sign (10-16 Sq.Ft.)	Ea./Day		1.30
High Intensity Reflective Sheeting, Large Sign (More than 16 Sq.Ft.)	Ea./Day		1.50
Std. Intensity Reflective Sheeting, Small Sign (Less than 10 Sq.Ft.)	Ea./Day		0.50
Std. Intensity Reflective Sheeting, Medium Sign (10-16 Sq.Ft.	Ea./Day		0.65
Std. Intensity Reflective Sheeting, Large Sign (More than 16 Sq.Ft.)	Ea./Day		1.00
Embedded Sign Posts	Ea./Day		0.10
Portable Sign Stand (Spring Type)	Ea./Day		2.10
Port. Sign Stand (9 Sq.Ft. or More)	Ea./Day		1.00
Port. Sign Stand (Under 9 Sq.Ft.)	Ea./Day		0.70
High Level Flag Tree	Ea./Day		0.80
Traffic Cones, 28 inch	Ea./Day		0.40
Drum (18" x 36")	Ea./Day		1.20

*Based on U.S. Dept. of Labor, General Wage Decision.

701-4.03 Relocation Services: of the Standard Specifications is revised to read:

Following the initial installation of the elements of work described in Subsection 701-4.02, the Engineer may direct the contractor to move any element of work from one location and re-erect it at another location. Except as hereinafter specified for Temporary Concrete Barrier (New Installation) or the exceptions specified in the remainder of this Subsection or Subsection 701-4.04, measurement for reimbursement of the work associated with such relocations will be made as specified for the Relocation Service elements of work.

When work of a progressive nature is involved, such as resurfacing a road under traffic, or closing a lane or lanes for work to be accomplished during a shift, no measurement for reimbursement will be made for setting up or relocating the necessary traffic control equipment, workmen, devices, facilities, signs (except semi-permanent signs on embedded posts), etc., that are moved concurrently with the advancing operation, or removal at the end of the shift. The cost of such work to be considered as included in Item 7010006.

701-5 Method of Measurement: the sixth and the last elements of work of paragraph one of the Standard Specifications are revised to read:

Flagging Services will be measured by the hour for each hour that a civilian flagger is provided and for each hour that a uniformed, off-duty law enforcement officer is employed directly by the contractor as a flagger, when authorized in advance by the Engineer. The time for a uniformed off-duty law enforcement officer used as a flagger will be measured in accordance with the following table:

Consecutive Hours Worked	Reimbursement Time Factor
First eight hours.............	straight time
Hours nine through twelve.....	time and one half
Over 12 hours.................	double time

Overtime hours will be converted into straight time hours for measurement. An off-duty law enforcement officer shall not work more than 12 consecutive hours unless an emergency situation exists which, in the opinion of the Engineer, requires that the officer remain in the capacity of flagger. In the event an off-duty officer reports to the project site and the work shift is cancelled within the first two hours, the contractor will be reimbursed for two hours at the appropriate rate. Flaggers used for the contractor's convenience, such as ingress and egress of construction equipment along the project traveled way, will not be measured for payment.

Vertical Panels, Barricades, Warning Lights, Signs, Sign Stands/Posts, Traffic Cones, Tubular Markers, Flag Trees, and Drums will be measured as a unit for each device furnished and subsequently utilized at the project site.

701-5 Method of Measurement: of the Standard Specification is modified to add:

Item 7010006 will be measured by the unit "lump sum" and shall include the furnishing and installation of all necessary temporary traffic control devices measured individually as provided above.

Overtime hours for flagging services flaggers and for relocation service barricade setters shall be converted into straight time hours for measurement on the basis of one and one half times the number of man hours for all approved flagging and relocation service barricade setter hours worked in excess of 40 hours per week.

Specialty Signs are signs which are required on the job, as determined by the Engineer, but which are not indicated on the project plans and are not included in item 7010006 or among reusable traffic control signs. The size, type and legend on Specialty Signs will be determined by the Engineer and will be measured for payment by the square foot.

Obliterate Pavement Legends or Arrows will be measured by each separate symbol, arrow or single letter.

701-5 *Method of Measurement: the first paragraph at the top of page 418 of the Standard Specifications is revised to read:*

Truck Driver (Pilot Truck, Relocation Service Truck and Truck Mounted Attenuation Device) will be measured by the hour for each hour that the Driver operates the vehicle. Overtime hours will be converted to straight time hours for measurement.

701-6 Basis of Payment: of the Standard Specifications is revised to read:

The contractor will be compensated for accepted quantities of Maintenance and Protection of Traffic in accordance with the procedures described herein and in Subsection 701-4 of the Standard Specifications.

701-6.01 Elements of Work (Bid Items): of the Standard Specifications is modified to add:

(C) Furnish and Install Temporary Traffic Control Devices:

Item 7010006 - Furnish & Install Temporary Traffic Control Devices is included in the Bidding Schedule to establish a bid item which shall be full compensation for furnishing to the jobsite, stockpiling, and installation of flashing arrow panels, changeable message boards, vertical panels, barricades, warning lights, signs, sign stands/posts, traffic cones, tubular markers, flag trees, and drums, complete-in-place. Item 7010006 also includes the cost of relocation of all necessary traffic control devices or the moving of devices for the Contractor's advancing operation as specified herein and as shown on the plans, *except for items directed by the Engineer.*

The cost of additional information traffic control signs, shown on the project plans, furnished by the contractor and not included as reusable traffic control signs as listed in Subsection 701-4.02(C), will be included in Item 7010006, which costs shall include all materials, labor and other additional costs for the installation, any relocation and removal of the signs.

Item 7010006 also includes removal of all temporary traffic control devices used for maintenance and protection of traffic on the project and included in the Elements of Work (In Use) and Elements of Work (Complete-in-Place), unless such cost is included in the predetermined reimbursement rates as specified in this Subsection.

Signs mounted on posts set in the ground shall be removed at the completion of the project, the post holes filled and compacted, and the immediate area restored to match the surrounding area. The cost of such removal and restoration shall be considered as included in the cost of Item 7010006.

Furnish and install temporary traffic control devices will be paid for at the contract lump sum price, which shall be full compensation for furnishing, installing, and removing all devices and the labor, tools, equipment, and incidentals necessary to complete the work.

Twenty five percent of the unit price bid will be paid upon satisfactory initial installation of temporary traffic control devices. The remaining seventy five percent will be paid in monthly increments based on the current month's percentage of project completion.

701-6.02 Elements of Work (Complete-in-Place):

701-6.02(E) Specialty Signs:

The accepted quantities of Specialty Signs will be paid for at the predetermined rate per square foot listed in Subsection 701-4.02(B). The rate established shall be full compensation for manufacturing, delivery to the job site, erection complete in place, and eventual removal.

701-6.02(F) Remove Raised Pavement Markers:

The accepted quantities for removal of Raised Pavement Markers will be paid for at the predetermined rate each listed in Subsection 701-4.02(B).

701-6.02(G) Obliterate Pavement Legends or Arrows:

The accepted quantities of Arrows, Symbols or individual Letters obliterated shall be paid for at the predetermined rate each listed in Subsection 701-4.02(B).

701-6.03 Elements of Work (In Use):

701-6.03(H) Operators: is revised to read:

(H) Truck Drivers(Pilot Truck, Relocation Service Truck and Truck Mounted Attenuation Device):

The accepted quantities of Truck Drivers, measured as provided under Subsection 701-5 of the Specifications, will be paid for at the predetermined reimbursement rate per hour, which rate shall be full compensation for the work, complete, including, but not limited to, all overhead costs and fringe benefits. No additional payment will be made to the contractor if the rate he is required to pay exceeds the predetermined reimbursement rate.

701-6.03(K) Vertical Panels, Barricades, Warning Lights, Signs, Sign Stands/Posts, Traffic Cones, Tubular Markers, Flag Trees, and Drums: of the Standard Specifications is revised to read:

The accepted unit quantities of vertical panels, barricades, warning lights, signs, sign stands/posts, traffic cones, tubular markers, flag trees and drums, measured as provided above on a daily basis, will be paid for at the predetermined reimbursement rate, which rate shall be full compensation for the use and maintenance of each device (in use).

Payment for relocation of vertical panels, barricades, warning lights, signs, sign stands, traffic cones, tubular markers, flag trees, drums, and work of a progressive nature will be made in accordance with the procedures of Subsection 701-4.03.

The work of removing and reinstalling signs on embedded posts will be reimbursed at the relocation service rates, regardless of the type of work or operation, when directed by the Engineer.

The predetermined reimbursement rate for signs, vertical panels, and flag trees includes the cost of flags and ballasting.

The predetermined reimbursement rate for barricades includes the cost of ballasting.

(PLSTC704, 454/7, 04/14/89)

SECTION 704 - THERMOPLASTIC STRIPES AND MARKINGS: of the Standard Specifications is modified as follows:

704-3.02 - Application: The first paragraph is replaced by:

The contractor shall remove all dirt, dust, grease, oil or other detrimental material from the road surface prior to application of the thermoplastic material. The method of cleaning the surface is subject to approval by the Engineer and shall include sweeping and the use of high-pressure air spray. The cost for cleaning the surface, including sweeping and high-pressure air spray, shall be considered part of the cost for applying thermoplastic striping and no separate measurement or payment will be made for this work.

When thermoplastic striping, symbols or legends are to be applied to new portland cement concrete pavement, any curing compound present shall be removed by means of a high-pressure water jet or sandblasting, followed up by sweeping and high-pressure air spray. On both old and new portland cement concrete pavement a primer-sealer, as recommended by the thermoplastic manufacturer, shall be applied prior to placing the thermoplastic material to assure a satisfactory bond.

The air and road surface temperature at the time of application shall not be less than 50 degrees F. and the pavement surface shall be absolutely dry.

The first two sentences of the second paragraph are replaced by:

The thermoplastic striping and markings shall be a minimum of 0.060 inches thick in all applications.

704-4 Method of Measurement: is revised to add:

Removal of curing compound from new portland cement concrete pavement and the application of primer-sealer, which is to be applied to both old and new portland cement concrete pavement, prior to application of thermoplastic striping or marking, shall be measured by the linear foot or unit each, respectively, depending on the nature of the work to be done, and in accordance with the items of work established in the Bid Schedule.

704-5 Basis of Payment: is revised to add:

The accepted quantities for removal of curing compound from new portland cement concrete pavement and the application of primer-sealer, measured as provided above, will be paid for at the contract unit price for each, respectively, under the items of work established in the Bid Schedule.

(PVMRK705, 454/9, 10/12/88)

SECTION 705 - PREFORMED PLASTIC PAVEMENT MARKING:

705-2.01 Preformed Pavement Markings - Type I (Permanent): of the Standard Specifications is modified to add:

(D) Performance Testing: The following are approved Type I Preformed Pavement Marking Materials:

Stamark Brand Series 5730/5731
3M Corporation
St. Paul, Minnesota 55144

Stamark Brand Series 350/351
3M Corporation
St. Paul, Minnesota 55144

Ferro/Cataphote
Ferro Corporation
P.O. Box 2369
Jackson, Mississippi 39225-2369

Materials other than those listed above may be used but must be approved by the Department prior to use.

705-3 Construction Requirements: The second paragraph is revised to read:

Preformed pavement markings shall be applied to surfaces that are free of moisture and thoroughly cleaned of loose, foreign or other material that may adversely affect bonding. The contractor shall remove all dirt, dust, grease, oil or other detrimental material from the road surface. The method of cleaning the surface is subject to approval by the Engineer and shall include sweeping and the use of high-pressure air spray. Newly placed surfaces need not be cleaned unless, in the opinion of the Engineer, the surface has become contaminated to the extent that cleaning is necessary to provide proper bonding. Preformed pavement markings shall be applied immediately after the surface has been prepared or as soon as possible after placement and completion of new pavement. At the time of application, the road surface temperature shall not be less than 60 degrees F. and the pavement surface shall be absolutely dry. For temporary markings, the weather conditions noted above may be waived, at the Engineer's discretion, to obtain a traffic stripe prior to allowing traffic to traverse the roadway. Despite the required minimum surface temperature and surface condition, the Engineer, at any time, may require that work cease or that the work day be reduced in the event of weather conditions, either existing or expected, which would have an adverse affect upon the working conditions.

(PVMRK706, 454/8, 10/20/88)

SECTION 706 - RAISED PAVEMENT MARKERS: of the Standard Specifications is modified as follows:

706-2.02 Reflective Pavement Markers:

The table listing the types of reflective markers used is modified to delete Type B, Clear, Two-way.

The fourth paragraph is revised to read:

Reflective pavement markers will be tested for compressive strength.

The first sentence of the sixth paragraph is revised to read:

The specific intensity of each clear reflecting surface shall be not less than the following:

706-2.05 Epoxy Adhesive: is hereby deleted.

706-2.06 Bituminous Adhesive: is hereby added:

The bituminous adhesive for pavement markers shall be a hot-melt adhesive manufactured by one of the following approved manufacturers:

Signal Products Divsion
Amerace Corporation
7542 N. Natchez Avenue
Niles, Illinois 60648

or

CRAFCO, Incorporated
P.O. Box 20133
Phoenix, Arizona 85036

Materials other than those listed above may be used but must be approved by the Department prior to use.

706-3 Construction Requirements: of the Standard Specifications is modified to read:

The portion of the highway to which the markers are to be attached shall be free of dirt, existing painted lines, curing compound, grease, oil, moisture, loose or unsound layers and any other material which could adversely affect the bond of the adhesive. The method of cleaning the pavement surface and removal of detrimental material is subject to approval by the Engineer and shall include sweeping and the use of high-pressure air spray. On portland cement concrete pavement and old asphaltic concrete pavements, cleaning shall be accomplished by sandblasting, followed by sweeping and/or air blowing. Newly placed asphaltic concrete pavement need not be sandblasted unless, in the opinion of the Engineer, the surface is contaminated with materials that would adversely affect the bond of the adhesive.

The adhesive shall be placed uniformly on the cleaned pavement surface in an amount sufficient to result in complete coverage of the area of contact of the markers, with no voids present and with a slight excess after the markers have been placed. The markers shall be placed in position and pressure applied until firm contact is made with the pavement. The markers shall be protected against impact until the adhesive has set to the degree acceptable to the Engineer.

Excess adhesive on the pavement and on the exposed surfaces of the markers shall be immediately removed. Thinners or solvents which may be detrimental to either the markers or the bond provided by the adhesive shall not be used in removing excess adhesive.

Markers shall not be installed when the temperature of the pavement surface or the atmosphere is less than 40 degrees Fahrenheit, when the relative humidity is 80 percent or higher or when the pavement surface is not dry.

All markers shall be installed to the line approved by the Engineer and in such manner that the reflective face of the markers is perpendicular to a line parallel to the roadway centerline. No pavement markers shall be installed over longitudinal or transverse joints of the pavement surface.

(PPM708, 453/8, 10/13/88)

SECTION 708 - PERMANENT PAVEMENT MARKINGS:

708-2 Materials:

708-2.01 Pavement Marking Paint:

(A) General:

All material used in the formulation of the pavement marking paint shall meet the requirements herein specified. Any materials not specifically covered shall meet the approval of the Engineer.

(B) Composition Requirements:

The permanent pavement marking paint shall consist of the following components with all percentages specified being by weight:

(1) Pigment Composition: percent by weight of total pigment

	White	Yellow
Titanium Dioxide, Rutile (ASTM D 476, Type II 92% min.)	24.0-26.0	7.0-9.0
Medium Chrome Yellow (ASTM D 211, Type III 87% min.)		15.0-17.0
Zinc Oxide (ASTM D 79 American Process Type)	7.5-9.5	7.0-9.0
Magnesium Silicate (ASTM D 605)	36.0-38.0	35.0-37.0
Calcium Carbonate (ASTM D 1199, Type GC, Grade I or II)	28.0-30.0	31.0-33.0
Antisettling Agency (Bentone 34 or Claytone 40) See Note 1		

(2) Vehicle Composition: percent by weight

	White and Yellow
Alkyd Resin Solution - See Note 2	21.3 min.
Chlorinated Rubber (Parlon S20 or Alloprene X20)	16.4 min.
Chlorinated Paraffin (Fed. Spec. Mil-C 429C, Type I)	11.3 - 13.3
Lead Drier 24% (ASTM D 600 Class B)	0.2 - 0.4

(C) Manufacturing Formulations:

The typical formula which may serve as a guide for the pain manufacture is as follows: (Yield is approximately 100 gallons).

	POUNDS White	POUNDS Yellow
Titanium Dioxide	150	50
Medium Chrome Yellow		100
Zinc Oxide	50	50
Magnesium Silicate	224	224
Calcium Carbonate	175	200
Antisettling Agent (Claytone)	5	5
Methanol	2	2
Alkyd Resin Solution (60% non-volatile)	130	130
Chlorinated Rubber (93% non-volatile)	100	100
Chlorinated Paraffin	75	75
24% Lead Drier	2	2
6% Cobalt Drier	1	1
Antiskinning Agent (Exkin)	3	3
Stabilizer (Propylene Oxide)	3	3
Toluene	160	160
Heptane	45	45
Methyl Ethyl ketone	90	90
	1215	1240

(D) Quantitative Requirements of Mixed Paint:

	White	Yellow
Pigment: percent by weight-See Note 5	48.9-50.6	49.9-51.6
Total Solids: percent by weight	69.4 min.	70.0 min.
Non-volatile Vehicle: percent by weight vehicle	38.9 min.	38.9 min.
Viscosity: K.U. at 77 F	76 ± 8	76 ± 8
Weight per Gallon: pounds	12.1 ± 0.2	12.4 ± 0.2
Fineness of Grind: Hegman gauge, North Standard Scale	3 min.	3 min.

Drying Time: minutes	1 - 4	1 - 4
Directional Reflectance:	80 min.	50 min.
Uncombined Water: percent by weight of paint	1.0 max.	1.0 max.
Coarse Particles and Skins: retained on a No. 325 mesh sieve, percent by weight of pigment.	1.0 max.	1.0 max.

Note 5. The extracted pigment upon analysis shall conform to the quantitative compositional requirements.

(E) Qualitative Requirements:

(1) Color of Yellow paint:

The color of the yellow paint shall visually match color chip No. 33538 of Fed. Std. 595 (Note 6). In case of dispute, the color shall be within the green and red tolerance limits when compared with the standard color chips of "Highway Yellow Color Tolerance Chart" U.S. Department of Commerce, Bureau of Public Roads PR Color No. 1, June 1965.

(2) Condition in Container:

The paint shall not show excessive settling in freshly-opened full can and shall be easily redispersed with a paddle to a smooth homogeneous state. The paint shall show no curdling, livering, caking, gelling or thixotropic properties, lumps, skins or color separation.

(3) Skinning:

The paint shall not skin within 48 hours in a three-quarter filled, tightly closed container.

(4) Storage Stability:

The paint shall show a viscosity increase of not more than five (5) Krebs units above the original viscosity and the degree of settling shall have a rating of six (6) or better (Note 7). When stored for twelve (12) months the paint must be usable, the drying time shall be as specified and the consistency range shall be -68 to 84 Krebs units.

(5) Flexibility and Adhesion:

The paint shall show no cracking, flaking or loss of adhesion when tested as specified. Apply a wet film thickness of 0.005 inches with a film applicator to a 3 by 5 inch tin panel weighing 0.39 to 0.51 lbs. per sq.ft., previously cleaned with a Hydrocarbon Solvent and lightly buffed with steel wool. Dry the paint film at 70 degrees to 80 degrees F in a horizontal position for 18 hours, then bake in an oven at 122 degrees ± 4 degrees F (47.8 degrees C to 52.2 degrees C) for two hours, cool to room temperature for at least 1/2 hour and bend over a 1/2 inch diameter rod and examine, without magnification.

(6) Water Resistance:

The paint shall show no softening, blistering, loss of adhesion or other evidence of deterioration other than a slight loss in gloss when tested as specified. Apply a wet film thickness of 0.015 inches with a film applicator to a clean glass plate. Let dry in a horizontal position at room temperature (70 degrees to 80 degrees F) for 72 hours. Immerse one-half the painted plate in distilled water at room temperature for 18 hours as specified in method 6011 of Fed. Test Method Std. No. 141, allow to dry for two hours and examine.

(7) Dilution Stability:

The thinned paint shall be uniform and show no separation, curdling or precipitation after reduction in the properties of eight parts by volume of the package material with not more than one part by volume of the appropriate thinner for each type of paint.

(8) Spraying Properties:

The paint as received or diluted no more than specified above shall have satisfactory spraying properties when applied (and held in a horizontal position) to tinplate or aluminum surfaces at a wet film thickness of approximately 0.015 inch. The sprayed film shall dry to a smooth uniform finish, free from roughness, grit, unevenness and other surface imperfections. The paint shall show no streaking or separation when placed on clean glass.

(9) Bleeding:

The bleeding characteristics shall be determined in accordance with ASTM D 969. The test panels shall be evaluated according to ASTM D 868, and the degree of resistance to bleeding shall have a numerical rating of six (6).

Note 6. Apply a wet film of 0.015 inches to a tin panel; let dry for 24 hours and compare color.

Note 7. Storage stability shall be determined in accordance with ASTM D 1309 Settling Properties of Traffic Paints During Storage; ASTM D 869 Evaluating Degree of Settling; and Consistency, Krebs-Standard Method 4281 of Federal Test Method Std. No. 141.

(F) Manufacturing Requirements:

(1) Inspection:

The manufacture shall advise the Engineer when paint is to be manufactured and shall furnish the Engineer free access to all parts of the plant and shall furnish every reasonable facility for sampling both the paint and the raw materials during the process of manufacturing.

All materials used in formulation shall meet the requirements herein specified. Any materials not specifically covered shall meet the approval of the Engineer.

(2) Testing:

All tests will be conducted in accordance with the latest test methods of the American Society for Testing and Materials, Federal Test Method Standard No. 141, and methods in use by Materials Services, Highways Division, and the Arizona Department of Transportation. Where both an ASTM and Federal Test Method is available for new materials or the finished product, the ASTM test method will prevail.

Evidence of adulteration or improper formulation shall be cause for rejection.

(3) Packaging:

The finished paint shall be homogeneous, free of dirt, water and other foreign matter. The paints shall be strained immediately prior to canning.

All shipping containers must comply with Federal Interstate shipping standards of the Department of Transportation, and be stamped 17-H in accordance with the standards. The containers must be lined so as to prevent attack by the paint. The lining must not come off the container as skins.

All containers of paint shall be labeled with weatherproof markings, showing the color, manufacturer's name, date of manufacture, tare weight, net weight, gross weight and manufacturer's batch number on the side of drum and also on the lid.

Remove approximately 60 grams of beads from the desiccator and weigh the sample accurately.

Pour the beads slowly in a clean 100 ml graduated cylinder containing 50 ml of isopropyl alcohol. Make certain that air is not entrapped among the beads.

The total volume, minus 50, will give the volume of the beads.

Calculate the specific gravity as follows:

$$\text{Specific Gravity} = \frac{\text{Weight of sample}}{\text{Volume of the sample}}$$

(5) Chemical Stability:

Beads which show any tendency toward decomposition, including surface etching, when exposed to atmospheric conditions, moisture, dilute acids, or alkalies or paint film constituents, may be required to demonstrate satisfactory reflectance behavior, prior to acceptance, under such tests as may be prescribed.

(C) Moisture Proofing:

All glass beads shall have a moisture-proof overlay consisting of water repellent material applied during the process of bead manufacture. The beads so treated shall not absorb moisture in storage and shall remain free of clusters and lumps and shall flow freely from dispensing and testing equipment.

The beads shall pass the test for water repellency and free flow using the following equipment:

(1) Test bag:

The bag used is approximately 10 1/2 inches x 17 1/2 inches after sewing. The material used in the construction of the bag is unbleached cotton sheeting with a thread count of 48 x 48. The material before sewing is approximately 18 inches x 22 inches. The cloth is folded in half lengthwise and stitched in the shape of an "L" with the short side left open at the top. The material can be obtained from selected manufacturers of cloth and paper packaging. The finished bag may also be obtained from the manufacturer of the glass beads.

Newly fabricated bags must be thoroughly washed with hot water and detergent and rinsed before use to remove the sizing which may be present in the cloth. Subsequent to the initial washing, the bags need only be rinsed clean of beads from previous tests and dried thoroughly before use.

(2) Funnel:

The funnel used is a standard laboratory funnel with a top opening diameter of 125 mm. and 150 mm. stem length. The inside diameter of the stem is between 9 and 10 mm. This funnel is available from most laboratory glassware supply houses. Corning No. 6100 or equal.

(3) Ring Stand and Clamp.

(4) Balance accurate to 0.1 grams.

(5) Distilled water.

MOISTURE TESTING PROCEDURE:

Glass beads shall be tested for compliance to specification requirements. Testing shall be conducted at standard conditions of temperature (25 ± 1 degrees C) and humidity (50 ± 5 percent R.H.) and shall consist of the following procedure or an approved alternate:

Weigh 900.0 grams of glass beads into a clean, dry, flat-bottomed pan.

Dry beads at 150 degrees C for two hours.

Cool beads to room temperature (25 ± 1 degrees) in a desiccator.

Using the clean, pre-washed bag described under apparatus section, turn the bag inside-out so that the sewn seam and seam-allowance are on the outside.

Quantitatively transfer the beads into the inverted cotton bag.

Grasp the gathered top of the bag with one hand and lower the bag into a container of distilled water until the beads are approximately one inch below the water level. The container shall be of such dimensions that the bag does not contact the bottom or sides during immersion. Each bag shall be immersed individually. Do not allow one bag to contact another if multiple tests are run.

Remove the bag after 30 seconds of immersion time.

Cradle the bottom of the bag uniformly in the palm of one hand and twist the top neck of the bag until the twisted bag is compressed firmly against the beads. Twist until excess water no longer drips from the bag.

After the excess water has been squeezed from the bag, allow the bag to unwind.

Gather the top of the bag and clamp. Suspending the bag on a ring stand or other support such that the bottom or sides of bag do not contact the support.

After a standing time of 2 hours at room temperature 25 degrees ± 1 degrees C, remove bag from support. Mix sample thoroughly by holding the bottom seam allowance in one hand and gathered neck of the bag in the other, invert bag and shake up and down 5 times.

Transfer the sample into a clean, dry funnel of the type described under apparatus. if consecutive tests are run, be sure the funnel is clean, dry and free of beads from prior tests.

The entire sample shall flow through the funnel without stoppage.

At the start of the test only, it is permissible to lightly tap the stem of the funnel to initiate flow.

Small quantities of beads which have adhered to the side of the funnel or stem shall not be cause for failure.

708-3 Construction Requirements:

708-3.01 Equipment:

The traffic paint and beads shall be placed on the pavement by a spray-type, self-propelled pavement marking machine except that temporary striping during construction may be placed with other equipment designed for application of paint and beads.

The application equipment to be used on roadway installation shall have, as a minimum, the following characteristic and/or apparatus:

The machine shall be capable of applying a clear-cut 4-inch line or lines.

The machines shall be equipped with a mechanical device capable of placing a broken reflectorized line with a 10-foot painted segment and a 30-foot gap.

The machine shall be equipped with an air-operated glass bead drop-in dispenser controlled by the spray gun mechanism.

A glass bead dispenser which is capable of placing the glass beads into the paint line as the paint is applied to the pavement shall be utilized. This dispenser shall provide satisfactory marking and delineation.

708-3.02 Application:

Pavement markings shall be applied when the pavement surface is dry and the weather is not foggy, rainy, or otherwise adverse to the application of markings. The surface shall be free from excess asphalt or other deleterious substances before traffic paint, beads or primer are applied. The contractor shall remove dirt, debris, grease, oil, rocks or chips from the pavement surface before applying markings. The method of cleaning the pavement surface and removal of detrimental material is subject to approval by the Engineer and shall include sweeping and the use of high-pressure air spray. The placing of traffic markings shall be done only by personnel who are experienced in this work.

The volume of paint in place shall be determined by measuring the paint tank with a calibrated rod. At the option of the Engineer, if the striping machine is equipped with air-atomized spray units (not airless) and paint gauges, the volume of paint may be determined by utilizing said gauges.

The quantity of glass reflectorizing beads in place shall be determined by measuring the glass reflectorizing bead tank with a calibrated rod.

The contractor shall provide the necessary personnel and equipment to divert traffic from the installation area where the work is in progress and during drying time when, in the opinion of the Engineer, such diversion of traffic is necessary.

Tolerances for Placing Paint, Beads, and Primer:

The length of painted segment and gap shall not vary more than 6 inches in a 40-foot cycle.

The finished line shall be smooth, aesthetically acceptable and free from undue waviness.

Painted lines shall be 4, 8, or 12 inches wide as shown on the plans with a tolerance of plus or minus 1/8 inch and shall be placed at a minimum rate of 16 gallons per mile for a solid 4-inch line and 4 gallons per mile for a broken 4-inch line, based on a 10-foot stripe and a 30-foot gap (40-foot cycle aggregate).

Glass reflectorizing beads shall be applied on the wet paint at a minimum rate of 6 pounds to each gallon of paint.

Wet mil thickness shall not be less than 15 mils.

708-4 Method of Measurement:

Pavement marking paint will be measured by the linear foot along the centerline of the pavement stripe. Skips in dashed lines will not be included in the measurement. Length of pavement markings will be based on four inch wide stripe. Measurement for striping with a plan width greater or less than the basic four inches as shown on the plans or directed by the Engineer will be made by the following method:

$$\frac{\text{Plan Width of Striping (inches)} \times \text{Linear Feet}}{4 \text{ (inches)}}$$

Symbols and legends will be measured by each unit applied. Each legend, regardless of the number of letters, will be considered as a single unit.

(LOOP735, 453/!, 09/30/88)

SECTION 735 - DETECTORS: of the Standard Specifications is modified to add:

735-1 Description:

The work shall consist of furnishing all materials and installing a complete Detector Loop Traffic Counter System at the approximate location shown on the project plans and in conformance with the requirements of Section 735 of the Standard Specifications and Standard Drawings T.S. 7-1 and T.S. 7-3. The exact location will be specified by the Engineer. Installation shall be in accordance with ADOT's "Detector Loop Traffic Counter System Installation Procedures" Manual, dated September, 1986.

A complete traffic counter system for an undivided roadway shall consist of the number and size of loops and pullboxes necessary at one location in one roadway to cover all travel lanes. Each through lane shall contain a detector loop.

A complete traffic counter system for a multi-lane divided roadway shall consist of the number and size of loops and pullboxes required to cover all travel lanes in adjacent roadways for one location. Each through lane shall contain a detector loop.

735-2 Materials:

735-2.05 Detector Loop Traffic Counter System:

(A) General:

The contractor shall submit to the Engineer three copies of a complete list of the materials the contractor proposes to incorporate into the project, and three copies of shop drawings for each system indicating the project number and location (milepost and/or station number). The list of materials shall include the brand or trade names, identification numbers, type and quantity of materials to be used. The shop drawings shall include the size of loops, length of loop lead-ins, and location of pullbox(es), all in relationship to the roadway.

No material shall be ordered or installed without the approval of the Engineer.

(B) Loop Conductors:

The conductors for each inductive detector loop shall be No. 14 AWG stranded copper wires, Type THWN, 600 Volt, continuous and unspliced and inserted in polyvinyl chloride tubing.

(C) Conduit and Tubing - PVC:

The polyvinyl chloride tubing shall be UL FR-1 rated at 105 degrees, 31 mil minimum wall thickness, inner diameter .182 to .198 inch, dielectric strength 900 V/CM, moisture absorption less than one percent, and highly resistant to chemicals and oil.

Conduit shall be rigid nonmetallic (PVC) conforming to the requirements of the Specifications and shall be sized large enough to contain the number of loop lead-ins required and be a minimum of two inches in diameter.

(D) Pullboxes:

Pullboxes shall be No. 5 conforming to the requirements of the Specifications and to Standard Drawing T.S. 1-2.

(E) Saw Cut Sealant:

The sealant shall be an approved crack filler emulsion and sand, or epoxy loop sealant conforming to the requirements of Subsection 735-2.04.

735-3 Construction Requirements:

735-3.01 General:

When loops are to be placed in existing pavements, saw cuts shall be made and the loops placed in accordance with the details shown on Standard Drawings T.S. 7-1 and T.S. 7-3.

The saw cuts shall be cleaned with clean water and blown dry by means of an air stream free of oil or water. They shall be inspected for jagged edges or protrusions prior to the placement of the wire. The wire shall be placed as far down in the saw cut as possible and in such a manner that the insulation is not damaged. The bend in the wire at any one point shall not exceed 45 degrees. The wire shall be held in place during installation by strips of polyethylene foam sealant backers two inches in length, placed approximately two feet apart. Wires crossing pavement joints shall be protected with plastic sleeving extending a minimum of four inches each side of the joint.

Loop detectors shall be installed in the new overlay pavement prior to placement of ACFC course.

735-3.02 Testing:

(A) General Requirements:

Any loop that fails to meet the requirements listed below, or will not tune when a detector is connected, shall be replaced at the contractor's expense.

(B) Preliminary:

The contractor shall perform the following tests on each loop in the presence of the Engineer both before and after the sealant has been poured and hardened:

1) Insulation Resistance to Ground - The insulation resistance to ground for each loop shall be measured with a megohmmeter connected to either loop lead-in and to the nearest reliable electrical ground, such as a metal light pole or fire hydrant, or to a metal rod driven three feet into the ground between the roadway and the pull box. The insulation to ground shall not measure less than 50 megohms at 500 volts DC.

2) Series Resistance - The series resistance of each six foot by six foot loop, measured by an ohmmeter, shall be between 0.1 and 0.5 ohms and the maximum resistance of any size loop including lead-ins shall not exceed 10 ohms.

The contractor shall submit two copies of the complete preliminary testing results to the Engineer.

(C) Final:

Final testing will be conducted by the Travel and Facilities Section of the Arizona Department of Transportation after the work is complete in place.

In addition to repeating the preliminary tests and recording the results, the following tests will be made:

1) Inductance - The inductance of each loop will be measured with an inductance tester. The inductance for a six foot by six foot loop with an 11 foot lead-in shall be in the range between 50 and 80 microhenries. The inductance may be greater with larger loops and longer lead-ins but in no case shall the total inductance exceed 700 microhenries.

2) Operation Test - A known working loop detector will be connected to each loop and the response observed under working conditions.

735-4 Method of Measurement:

The Detector Loop Traffic Counter System will be measured as a unit for each system installed and accepted.

735-5 Basis of Payment:

The work, measured as provided above, will be paid for at the contract unit price for each system, which price shall be full compensation for the work described and specified herein and on the plans.

(MOBL901, 453/@, 08/24/89)

SECTION 901 - MOBILIZATION:

901-5 Basis of Payment: the third, fourth and fifth paragraphs of the Standard Specifications are revised to read:

The first payment of the lump sum price for mobilization will be paid after the Preconstruction Conference provided that all submissions required under Subsection 108.03 are submitted by the contractor at the Preconstruction Conference to the satisfaction of the Engineer. The amount paid for the first partial payment will be in accordance with Table 1.

The second payment of the lump sum price for mobilization will be made when the Engineer has determined that a significant amount of equipment has been mobilized to the project site which will be used to perform portions of the contract work. The amount paid for the second partial payment will be in accordance with Table 1.

The third payment of the lump sum price for mobilization will be made on the first estimate following completion of 5 percent of the contract. The amount paid for the third payment will be in accordance with Table 1.

The fourth payment of the lump sum price for mobilization will be made on the first estimate following completion of 10 percent of the contract. The amount paid for the fourth payment will be in accordance with Table 1.

TABLE 1

CONTRACT AMOUNT	AMOUNT ALLOWED FOR MOBILIZATION DURING THE LIFE OF THE CONTRACT (% OF CONTRACT)	BASIS OF PAYMENT
0 - 5,000,000	12%*	25% of the lump sum price for mobilization or 3% of the original contract amount, whichever is less.
5,000,000+	10%*	25% of the lump sum price for mobilization or 2.5% of the original contract amount, whichever is less.

* If the price bid for mobilization exceeds this percentage, any excess will be paid to the contractor upon completion of the contract.

SECTION 905 - GUARD RAIL:

905-3.05 Reconstruct Guard Rail: of the Standard Specifications is modified to add:

The contractor shall furnish and install new 18 inch Button head-bolts, recss-nuts and wide type "A" plane washers in accordance with Standard Drawing C-10.04, as incidental to the price of contract item 9050110 "Reconstruct Guard Rail".

905-4 Method of Measurement: the seventh paragraph of the Standard Specifications is revised to read:

Reconstruct guardrail will be measured by the linear foot, along the face of the guard rail element.

Reconstruct rubrail, and reconstruct guardrail breakaway cable terminals, will be measured by the unit each.

905-5 Basis of Payment: the third paragraph of the Standard Specifications is revised to read:

No measurement or direct payment will be made for constructing the asphaltic concrete (End Product) pads at the flares of the breakaway cable terminal assemblies, the cost being considered as included in the price of contract item 4160002.

(CONCB910, 454/i, 06/20/88)

SECTION 910 - CONCRETE BARRIERS:

910-3.01 General: the second paragraph of the Standard Specifications is revised to read:

Concrete barriers shall present a smooth, uniform appearance in their final position, conforming to the horizontal and vertical lines shown on the project plans or ordered by the Engineer.

910-3.02 Cast-in-Place by Slip Form or Extrusion: the second paragraph of the Standard Specifications is revised to read:

Slip form or extruded barrier will be considered not to require additional finishing if the surface meets the requirements of a Class II finish as described in Subsection 601-3.05 and the alignment is satisfactory. If the extruded barrier does not meet these requirements, operations shall be stopped until adjustments are made to the equipment or the concrete mix that will result in an acceptable product. Barrier that cannot be refinished to meet the specifications for a Class II finish shall be removed and replaced at the contractor's expense. Barrier that has unsatisfactory alignment, as determined by the straightedge test in Subsection 601-4.02(C), shall be penalized or replaced in accordance with that Subsection.

910-3.03 Cast-in-Place by Fixed Forms: of the Standard Specifications is modified to add:

When a ten foot long straightedge is placed on the top and along the faces of the barrier, the surface shall not vary more than 1/4 inch from the straightedge.

910-3.04 Precast: of the Standard Specifications is modified to add:

When a ten foot long straightedge is placed on the top and along the faces of the barrier, the surface shall not vary more than 1/4 inch from the straightedge.

(TRN923, CS, 09/01/87)

ITEM 9230001 - PROVIDE TRAINEES WITH ON-THE-JOB TRAINING:

The number of trainees to be trained under this project shall be at least 4; however, the contractor shall make every possible effort to provide additional trainees with training and shall see that all trainees are afforded every opportunity to participate in as much training as is practically possible to provide.

As approved by the Engineer, reimbursement will be made for training of persons in excess of the minimum number specified herein.

At the preconstruction conference, the contractor shall submit a schedule which will indicate the approximate number of hours each trainee will be trained in each phase of the work, the crafts to which the trainees belong and the estimated period of time that they will be employed as trainees. A supplemental schedule shall be submitted to the Engineer when a revision in the original schedule is necessary.

(SURVY925, 454/r, 12/22/88)

SECTION 925 - CONSTRUCTION SURVEYING AND LAYOUT: the SECTION Heading of the Standard Specifications is revised as shown:

925-2 Materials, Personnel and Equipment: the second paragraph of the Standard Specifications is revised to read:

The contractor shall furnish all traffic control, including flagging for survey and staking operations, the cost being considered to be included in contract bid item 9250001 - Construction Surveying and Layout. Traffic control devices and procedures for construction surveying shall be in accordance with the requirements of the Traffic Control Manual.

925-3 Construction Requirements: the first paragraph of the Standard Specifications is revised to read:

Prior to beginning any survey operations, the contractor shall furnish to the Engineer, for his approval, a written outline detailing the method of staking, marking of stakes, grade control for various courses of materials, referencing, structure control, and any other procedures and controls necessary for survey completion. A part of this outline shall also be a schedule which will show the sequencing of the survey and layout work, throughout the course of the contract, listing a percentage of completion for each month. Section 1100-B, Chapter XI of the ADOT Construction Manual shall be used by the contractor as a guide in the preparation of this outline. The contractor may obtain a copy of Chapter XI, for a fee, from Engineering Records, 1655 West Jackson, Room 112F, Phoenix, AZ 85007, Phone (602) 255-7498.

925-3 Construction Requirements: the eleventh and twelfth paragraphs of the Standard Specifications are revised to read:

On projects where traffic is being carried through the work zone, pavements shall be marked for traffic centerline delineation before the end of each work shift. Temporary pavement markings shall conform with the requirements set forth under Subsection 701-3.05 of the Standard Specifications and any subsequent modifications thereto.

Any discrepancies in grade, alignment, earthwork quantities, locations or dimensions detected by the contractor shall immediately be brought to the attention of the Engineer. No changes in the project plans will be allowed without the approval of the Engineer. Requests for verification of earthwork quantities shall be in accordance with Subsection 102.06.

925-3 Construction Requirement: of the Standard Specifications is modified to add:

The existing centerline is coincidence with the construction centerline and shall constitute the only horizontal control points provided by the Department. No vertical control points will be established by ADOT.

The contractor shall adequately reference the existing roadway striping, to allow reestablishment to the same locations, to the satisfaction of the Engineer before milling and/or paving operations will be permitted.

All existing gores centerline and edgelines shall be as-built, and referenced by the contractor, and shall be used to establish roadway horizontal control. As-built drawings shall be submitted to the Engineer, for approval, prior to start of asphaltic concrete milling operation.

(RUMBL928, 454/t, 10/05/88)

SECTION 928 - FORMED RUMBLE STRIP:

928-3 - Construction Requirements: of the Standard Specifications is revised to read:

Rumble Strips shall be formed in the asphaltic concrete by making indentations approximately 7/8 inch deep by two feet in length and spaced at centers of approximately eight inches, in accordance with the details shown on the project plans.

A self-propelled vibratory roller, weighing at least six tons, may be used to form the Rumble Strips. If the rear tires are pneumatic, they shall have a smooth or slick tread design. The roller shall be equipped with an approved water system which will moisten the drums and tires so that the bituminous material will not be picked up. The roller shall also be equipped with an approved guide that extends in front of the roller and is clearly visible to the operator so that proper alignment of the strips will be obtained.

Other equipment may be used to construct the Rumble Strip, subject to approval by the Engineer.

The equipment used shall be positioned by using planking, or by other approved means, so that the asphaltic concrete is indented only at those locations specified on the plans and to the dimensions specified herein.

The forming of the Rumble Strips shall be accomplished in one pass of the equipment and while the asphaltic concrete is hot. The surface surrounding the indentations shall be smooth and not deformed. These requirements apply if the Rumble Strip is formed by the roller which is in the vibratory mode or by other equipment.

The asphaltic concrete shall be compacted to the degree specified in the appropriate section of the specifications.

(CONC1006, 454/h, 02/28/89)

SECTION 1006 - PORTLAND CEMENT CONCRETE:

1006-4.01 General Requirements: of the Standard Specifications is revised to read:

The contractor may obtain concrete for each Class of concrete and for each strength of Class S concrete from an approved commercial source in lieu of establishing a batch plant at the project site.

For each class of concrete and each strength of Class S concrete, except for Class P concrete produced in a batch plant at the site and used exclusively for Class P work, the contractor shall furnish an invoice for each batch of concrete. The minimum information to be shown on each invoice shall be the date, time batched, truck identification number, name or identification of batch plant, name of contractor, name and location of project, the volume of concrete, the batch weights or mix design code number, the estimated percent of free moisture in the coarse and fine aggregates, the amount of any water withheld during batching, and the number of revolutions that the concrete has been mixed at mixing speed in a truck mixer. An authorized representative of the contractor shall be responsible for each invoice and shall sign each invoice accepting the contractor's responsibility for the concrete as the concrete is being placed. He shall immediately furnish the invoice to the Engineer.

1006-4.02 Proportioning:

1006-4.02(B) Water: the first paragraph of the Standard Specifications is revised to read:

Water shall be measured by volume or by weight. Measurement by volume will be by metering.

DRA

1006-4.02(C) Aggregates: the second paragraph of the Standard Specifications is revised to read:

Suitable dial scales shall be provided by the contractor to weigh each size of aggregate, The scales shall be positioned so as to be easily visible to the Engineer and accurate to +0.2 percent of scale capacity. The weighing equipment shall have a batching accuracy of + two percent of the required weight. The weighing equipment shall be arranged so as to permit the convenient removal of excess material from the weighing hopper and the equipment shall be arranged to enable the operator to have convenient access to all controls, The scales shall be so equipped and the dials so graduated that the weights of materials being weighed can be accurately determined. Every expedient shall be used to obtain and preserve uniform moisture content in the coarse and fine aggregates. The moisture content shall not vary more than three percent during any day's production. The estimated percent of free moisture in each of the coarse and fine aggregates shall be determined by the contractor using acceptable test methods.

1006-4.03 Mixing:

1006-4.03(C) Mixing in Truck Mixers: of the Standard Specifications is revised to read:

Truck-mixed concrete shall be mixed entirely in the truck mixer and shall be mixed at the batch plant or at the site.

Truck mixers shall be operated within a capacity not to exceed 63 percent of the gross volume of the drum and at speeds shown on the manufacturer's plate as mixing and agitating speeds.

Any water added after the initial batching shall be measured. Measurement will be by metering or sight-glass. If sight-glass is used, the sight-glass shall be calibrated and clean, and the truck shall be level.

Each batch of concrete shall be mixed for not less than 70 nor more than 100 revolutions of the drum at mixing speed after all materials have been loaded into the drum, except that when approved by the Engineer, the maximum of 100 revolutions may be increased. Any revolving of the drum beyond the maximum number of revolutions shall be at the agitating speed. Mixing shall begin within ten minutes after the cement has been combined with either the aggregate or water.

The truck mixer shall be equipped with an electrically or mechanically activated revolution counter by which the number of drum revolutions may be verified. The counter shall be of the "continuous registering" type, which accurately registers the number of revolutions. It shall be mounted on the truck mixer or just inside the truck cab, so that it may be safely and conveniently read from beside the truck. The revolution counter shall be reset to zero after all materials have been loaded into the drum.

Discharge from the truck mixer shall be completed within 90 minutes from the time batched.

If additional mixing water is required to maintain the specified slump, the concrete shall be mixed by a minimum of 20 revolutions of the drum at mixing speed after the water has been added, prior to discharge of any concrete for placement. Any additional mixing water and required mixing revolutions shall be recorded on the invoice specified in Section 1006-4.01. This additional mixing may be in excess of the maximum revolutions previously specified.

1006-5 Weather Limitation:

1006-5.01 General Requirements: the third paragraph of the Standard Specifications is hereby deleted.

1006-7 Compressive Strength and Acceptance:

1006-7.05 Acceptance For Compressive Strength:

1006-7.05(B) Class S and Class B Concrete: the second paragraph of the Standard Specifications is revised to read:

If such evidence consists of concrete cores, the contractor shall obtain three cores from the concrete represented by the failing strength test and deliver them to the Engineer in time to allow complete testing of such cores within 42 days after the placement of the concrete. All cores shall be obtained and tested in accordance with the requirements of AASHTO T 24. All cores will be tested in the wet condition. The concrete represented by the cores will be considered acceptable if the numerical average of the three tests is 95 percent of the required 28 day compressive strength. If the average compressive strength does not meet this requirement, all concrete so represented shall be removed at the contractor's expense unless permitted to remain in place by the Engineer. If the concrete is permitted to remain in place, when the average compressive strength of the three cores fails to meet 95 percent of the required 28 day compressive strength, it will be paid for at 55 percent of the contract price.

(RUBR1009, 453/b, 05/01/89)

SECTION 1009 - ASPHALT RUBBER MATERIALS:

1009-2 Materials: The paragraph headed, 1009-2, Materials, on page 724 of the Standard Specifications is hereby deleted.

REQUIRED CONTRACT PROVISIONS
FEDERAL-AID CONSTRUCTION CONTRACTS

(Exclusive of Appalachian Contracts)

I. GENERAL

1. These contract provisions shall apply to all work performed on the contract by the contractor's own organization and with the assistance of workers under the contractor's immediate superintendence and to all work performed on the contract by piecework, station work, or by subcontract.

2. Except as otherwise provided for in each section, the contractor shall insert in each subcontract all of the stipulations contained in these Required Contract Provisions, and further require their inclusion in any lower tier subcontract or purchase order that may in turn be made. The Required Contract Provisions shall not be incorporated by reference in any case. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with these Required Contract Provisions.

3. A breach of any of the stipulations contained in these Required Contract Provisions shall be sufficient grounds for termination of the contract.

4. A breach of the following clauses of the Required Contract Provisions may also be grounds for debarment as provided in 29 CFR 5.12:

Section I, paragraph 2;
Section IV, paragraphs 1, 2, 3, 4, and 7;
Section V, paragraphs 1 and 2a through 2g.

5. Disputes arising out of the labor standards provisions of Section IV (except paragraph 5) and Section V of these Required Contract Provisions shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the U.S. Department of Labor (DOL) as set forth in 29 CFR Parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the DOL, or the contractor's employees or their representatives.

6. Certification of Eligibility: By entering into this contract, the contractor certifies as follows:

a. Neither the contractor nor any person or firm who has an interest in the contractor's firm is ineligible to be awarded Government contracts by virtue of Section 3(a) of the Davi Bacon Act, 29 CFR 5.12(a)(1), or 49 CFR 29.

b. No part of this contract shall be subcontracted to ar person or firm ineligible for award of a Government contra by virtue of Section 3(a) of the Davis-Bacon Act, 29 CF 5.12(a)(1), or 49 CFR 29.

c. The penalty for making false statements is prescrib in the U.S. Criminal Code, 18 U.S.C. 1001.

II. NONDISCRIMINATION

(Applicable to Federal-aid construction contracts and relat subcontracts and purchase orders exceeding $10,000.)

1. Selection of Labor: During the performance of th contract, the contractor shall not:

a. discriminate against labor from any other Stat possession, or territory of the United States, or

b. employ convict labor for any purpose within the limi of the project unless it is labor performed by convicts who ai on parole, supervised release, or probation.

2. Employment Practices:

a. The Equal Employment Opportunity Affirmative Actio Notice set forth in 41 CFR 60-4.2 and the Equal Employmer Opportunity Construction Contract Specifications set forth i 41 CFR 60-4.3 are incorporated by reference in this contrac

b. Regulation 41 CFR 60-4.2 requires goals and timetabl for minority and female participation expressed in percentag terms for the contractor's aggregate work force in each trad on all construction work in the covered area. The goals for thi contract are stated elsewhere in the bidding documents and i the construction contract.

c. Regulation 41 CFR 60-4.3 provides specific affirmativ action standards the contractor shall implement to ensure equa employment opportunity in achieving the minority and femal participation goals set forth in paragraph 2b of this Section

3. Equal Opportunity Clause: During the performance of thi contract, the contractor agrees as follows:

a. The contractor will not discriminate against an employee or applicant for employment because of race, color religion, sex, or national origin. The contractor will tak affirmative action to ensure that applicants are employed an that employees are treated during employment without regar to their race, color, religion, sex, or national origin. Such actio shall include, but not be limited to, the following: employment upgrading, demotion or transfer; recruitment or recruitmen advertising; layoffs or termination; rates of pay or other form of compensation; and, selection for training, includin apprenticeship. The contractor agrees to post in conspicuou places, available to employees and applicants for employment notices to be provided by the State highway agency (SHA setting forth the provisions of this nondiscrimination clause

b. The contractor will, in all solicitations or advertisement for employees placed by or on behalf of the contractor, stat that all qualified applicants will receive consideration fo employment without regard to race, color, religion, sex, o national origin.

c. The contractor will send to each labor union or representative of workers with which the contractor has a collective bargaining agreement or other contract or understanding a notice to be provided by the SHA advising the said labor union or workers' representative of the contractor's commitments under this Section II, paragraph 3.

d. The contractor will comply with all provisions of Executive Order 11246, Equal Employment Opportunity, dated September 24, 1965, and of the rules, regulations (41 CFR Part 60), and relevant orders of the Secretary of Labor.

e. The contractor will furnish all information and reports required by Executive Order 11246 and by rules, regulations, and orders of the Secretary of Labor, pursuant thereto, and will permit access to its books, records, and accounts by the Federal Highway Administration (FHWA) and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

f. In the event of the contractor's noncompliance with the nondiscrimination clauses of this Section II, paragraph 3, or with any of the said rules, regulations, or orders, this contract may be canceled, terminated, or suspended in whole or in part. The contractor may be declared ineligible for further Government contracts or federally-assisted construction contracts in accordance with procedures authorized in Executive Order 11246 and such other sanctions as may be imposed and remedies invoked as provided in Executive Order 11246 or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

g. The contractor will include the provisions of this Section II, paragraph 3, in every subcontract or purchase order so that such provisions will be binding upon each subcontractor or vendor, unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order 11246. The contractor will take such action with respect to any subcontract or purchase order as the SHA or the FHWA may direct as a means of enforcing such provisions, including sanctions for noncompliance. In the event a contractor becomes a party to litigation by a subcontractor or vendor as a result of such direction, the contractor may request the SHA to enter into such litigation to protect the interest of the State. In addition, the contractor may request the United States to enter into such litigation to protect the interests of the United States.

4. **Selection of Subcontractors, Procurement of Materials, and Leasing of Equipment:**

a. The contractor shall not discriminate on the grounds of race, color, sex, or national origin in the selection and retention of subcontractors, including procurement of materials and leases of equipment. In all solicitations made by the contractor each potential subcontractor or supplier shall be notified by the contractor of the contractor's obligations under this contract relative to nondiscrimination on the grounds of race, color, sex, or national origin.

b. In the event of the contractor's noncompliance with the nondiscrimination provisions of this Section II, paragraph 4, this contract may be subject to sanctions including but not limited to the withholding of payments to the contractor under the contract until the contractor complies and/or cancellation, termination, or suspension of the contract in whole or in part.

c. The contractor shall include the provisions of this paragraph 4 in every subcontract, including procurement of materials and leases of equipment. The contractor shall take such action with respect to any subcontractor or procurement as the SHA or the FHWA may direct as a means of enforcing such provisions, including sanctions for noncompliance. In the event a contractor becomes involved in, or is threatened with, litigation by a subcontractor or supplier as a result of such direction, the contractor may request the SHA to enter into such litigation to protect the interests of the State. In addition, the contractor may request the United States to enter into such litigation to protect the interests of the United States.

5. **General Participation Requirements:**

a. Policy: It is the policy of the DOT that disadvantaged business enterprises (DBE's), as defined in 49 CFR Part 23, shall have equal opportunity to participate in the performance of contracts financed in whole or in part with Federal funds. Consequently, the requirements of 49 CFR Part 23 apply to this contract.

b. Obligation: The contractor agrees to take all necessary steps to ensure that eligible businesses, as defined in 49 CFR Part 23, have equal opportunity to compete for and perform subcontracts financed in whole or in part with Federal funds provided under this contract.

c. The contractor's failure to carry out the requirements of paragraphs 5a and 5b of this Section II shall constitute a breach of contract and may result in termination of the contract or other appropriate action.

d. The contractor shall provide all information and reports required by 49 CFR Part 23 or directives issued pursuant thereto, and shall permit access to its books, records, accounts, other sources of information and its facilities as may be determined by the SHA or the FHWA to be pertinent to ascertain compliance with the regulations or directives.

III. NONSEGREGATED FACILITIES

(Applicable to Federal-aid construction contracts and related subcontracts exceeding $10,000.)

a. By submission of this bid, the execution of this contract or subcontract, or the consummation of this material supply agreement or purchase order, as appropriate, the bidder, Federal-aid construction contractor, subcontractor, material supplier, or vendor, as appropriate, certifies that the firm does not maintain or provide for its employees any segregated facilities at any of its establishments, and that the firm does not permit its employees to perform their services at any location, under its control, where segregated facilities are maintained. The firm agrees that a breach of this certification is a violation of the Equal Opportunity Clause in this contract. The firm further certifies that no employee will be denied access to adequate facilities on the basis of sex.

b. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, restrooms and washrooms, restaurants and other eating areas, timeclocks, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive, or are, in fact, segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or otherwise.

c. The contractor agrees that it has obtained or will obtain identical certification from proposed subcontractors or material suppliers prior to award of subcontracts or consummation of material supply agreements exceeding $10,000 and that it will retain such certifications in its files.

IV. PAYMENT OF PREDETERMINED MINIMUM WAGE

(Applicable to Federal-aid construction contracts exceeding $2,000 and related subcontracts.)

1. **General:**

a. All mechanics and laborers employed or working upon the site of the work will be paid unconditionally and not less often than once a week and without subsequent deduction or rebate on any account [except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR Part 3)] the full amounts of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment. The payment shall be computed at wage rates not less than those contained in the wage determination of the Secretary of Labor (hereinafter "the wage determination") which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor or its subcontractors and such laborers and mechanics. The wage determination (including any additional classifications and wage rates conformed under paragraph 2 of this Section IV and the DOL poster (WH-1321) or Form FHWA-1495) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers. For the purpose of this Section, contributions made or costs reasonably anticipated for bona fide fringe benefits under Section 1(b)(2) of the Davis-Bacon Act (40 U.S.C. 276a) on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of Section IV, paragraph 3b, hereof. Also, for the purpose of this Section, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs, which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in paragraphs 4 and 5 of this Section IV.

b. Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein, provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed.

c. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR Parts 1, 3, and 5 are herein incorporated by reference in this contract.

2. **Classification:**

a. The SHA contracting officer shall require that any class of laborers or mechanics employed under the contract, which is not listed in the wage determination, shall be classified in conformance with the wage determination.

b. The contracting officer shall approve an additional classification, wage rate and fringe benefits therefor only when the following criteria have been met:

(1) the work to be performed by the additional classification requested is not performed by a classification in the wage determination;

(2) the additional classification is utilized in the area by the construction industry; and

(3) the proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

c. If the contractor or subcontractors, as appropriate, the laborers and mechanics (if known) to be employed in the additional classification or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the U.S. Department of Labor Administrator of the Wage and Hour Division, Employment Standards Administration, Washington, D.C. 20210. The Wage and Hour Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

d. In the event the contractor or subcontractors, as appropriate, the laborers or mechanics to be employed in the additional classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Wage and Hour Administrator for determination. Said Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

e. The wage rate (including fringe benefits where appropriate) determined pursuant to paragraph 2c or 2d of this Section IV shall be paid to all workers performing work in the additional classification from the first day on which work is performed in the classification.

3. **Payment of Fringe Benefits:**

a. Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor or subcontractors, as appropriate, shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

b. If the contractor or subcontractor, as appropriate, does not make payments to a trustee or other third person, he/she may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, provided that the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

4. **Apprentices and Trainees (Programs of the U.S. Department of Labor):**

a. Apprentices:

(1) Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State apprenticeship agency recognized by the Bureau, or if a person is employed in his/her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of Apprenticeship and Training or a State apprenticeship agency (where appropriate) to be eligible for probationary employment as an apprentice.

(2) The allowable ratio of apprentices to journeyman-level employees on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any employee listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate listed in the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor or subcontractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman-level hourly rate) specified in the contractor's or subcontractor's registered program shall be observed.

(3) Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeyman-level hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator for the Wage and Hour Division determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination.

(4) In the event the Bureau of Apprenticeship and Training, or a State apprenticeship agency recognized by the Bureau, widthdraws approval of an apprenticeship program, the contractor or subcontractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the comparable work performed by regular employees until an acceptable program is approved.

b. Trainees:

(1) Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration.

(2) The ratio of trainees to journeyman-level employees on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed.

(3) Every trainee must be paid at not less than the rate specified in the approved program for his/her level of progress, expressed as a percentage of the journeyman-level hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman-level wage rate on the wage determination which provides for less than full fringe benefits for apprentices, in which case such trainees shall receive the same fringe benefits as apprentices.

(4) In the event the Employment and Training Administration withdraws approval of a training program, the contractor or subcontractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

c. Equal Employment Opportunity:

The utilization of apprentices, trainees, and journeymen-level employees shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, 23 CFR 230A, and 29 CFR Part 30.

5. **Apprentices and Trainees (Programs of the U.S. Department of Transportation):**

Apprentices and trainees working under apprenticeship and skill training programs which have been certified by the Secretary of Transportation as promoting equal employment opportunity in connection with Federal-aid highway construction programs are not subject to the requirements of paragraph 4 of this Section IV. The straight time hourly wage rates for apprentices and trainees under such programs will be established by the particular programs. The ratio of apprentices and trainees to journeymen shall not be greater than permitted by the terms of the particular program.

6. **Withholding:**

The SHA shall upon its own action or upon written request of an authorized representative of the DOL withhold, or cause to be withheld, from the contractor or subcontractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements which is held by the same prime contractor, as much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the SHA contracting officer may, after written notice to the contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

7. **Overtime Requirements:**

No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers, mechanics, watchmen, or guards (including apprentices and trainees described in paragraphs 4 and 5 above) shall require or permit any laborer, mechanic, watchman, or guard in any workweek in which he/she is employed on such work, to work in excess of 40 hours in such workweek unless such laborer, mechanic, watchman, or guard receives compensation at a rate not less than one-and-one-half times his/her basic rate of pay for all hours worked in excess of 40 hours in such workweek.

8. **Violation:**

Liability for Unpaid Wages; Liquidated Damages: In the event of any violation of the clause set forth in paragraph 7 above, the contractor and any subcontractor responsible therefor shall be liable to the affected employee for his/her unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory) for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer, mechanic, watchman, or guard employed in violation of the clause set forth in paragraph 7, in the sum of $10 for each calendar day on which such employee was required or permitted to work in excess of the standard workweek of 40 hours without payment of the overtime wages required by the clause set forth in paragraph 7.

9. **Withholding for Unpaid Wages and Liquidated Damages:**

The SHA shall upon its own action or upon written request of any authorized representative of the DOL withhold, or cause to be withheld, from any monies payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph 8 above.

V. STATEMENTS AND PAYROLLS

(Applicable to Federal-aid construction contracts exceeding $2,000 and related subcontracts.)

1. **Compliance with Copeland Regulations (29 CFR Part 3):** The contractor shall comply with the Copeland Regulations of the Secretary of Labor which are herein incorporated by reference.

2. **Payrolls and Payroll Records:**

a. Payrolls and basic records relating thereto shall be maintained by the contractor and each subcontractor during the course of the work and preserved for a period of 3 years from the date of completion of the contract for all laborers, mechanics, apprentices, trainees, watchmen, and guards working at the site of the work.

b. The payroll records shall contain the name, social security number, and address of each such employee, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in Section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor, pursuant to Section IV, paragraph 3b, has found that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in Section 1(b)(2)(B) of the Davis-Bacon Act, the contractor and each subcontractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual costs incurred in providing such benefits. Contractors or subcontractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

c. Each contractor and subcontractor shall furnish each week in which any contract work is performed to the SHA resident engineer a payroll of wages paid each of its employees (including apprentices and trainees described in Section IV paragraphs 4 and 5 and watchmen and guards engaged on work during the preceding weekly payroll period). The payroll submitted shall set out accurately and completely all of the information required to be maintained under paragraph 2b of this Section V. This information may be submitted in any form desired. Optional Form WH-347 is available for this purpose and may be purchased from the Superintendent of Documents (Federal stock number 029-005-0014-1), U.S. Government Printing Office, Washington, D.C. 20402. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors.

d. Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his/her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) that the payroll for the payroll period contains the information required to be maintained under paragraph 2b of this Section V and that such information is correct and complete;

(2) that such laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in the Regulations, 29 CFR Part 3;

(3) that each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

e. The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph 2d of this Section V.

f. The falsification of any of the above certifications may subject the contractor to civil or criminal prosecution under Section 1001 of Title 18 and Section 231 of Title 31 of the United States Code.

g. The contractor or subcontractor shall make the records required under paragraph 2b of this Section V available for inspection, copying, or transcription by authorized representatives of the SHA, the FHWA, or the DOL, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the SHA, the FHWA, DOL, or all may, after written notice to the contractor, sponsor, applicant, or owner, take such actions as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

VI. RECORD OF MATERIALS, SUPPLIES, AND LABOR

1. On all Federal-aid primary, urban, and Interstate System contracts, except those which provide solely for the installation of protective devices at railroad grade crossings, those which are constructed on a force account or direct labor basis, highway beautification contracts, and contracts for which the total final construction cost for roadway and bridge is less than $1,000,000 (23 CFR Part 635) the contractor shall:

a. Become familiar with the list of specific materials and supplies contained in Form FHWA-47, "Statement of Materials and Labor Used by Contractor of Highway Construction Involving Federal Funds," prior to the commencement of work under this contract.

b. Maintain a record of the total cost of all materials and supplies purchased for and incorporated in the work, and also of the quantities of those specific materials and supplies listed on Form FHWA-47, and in the units shown on Form FHWA-47.

c. Furnish, upon the completion of the contract, to the SHA resident engineer on Form FHWA-47 together with the data required in paragraph 1b relative to materials and supplies, a final labor summary of all contract work indicating the total hours worked and the total amount earned.

2. At the prime contractor's option, either a single report covering all contract work or separate reports for the contractor and for each subcontract shall be submitted.

VII. SUBLETTING OR ASSIGNING THE CONTRACT

1. The contractor shall perform with its own organization contract work amounting to not less than 30 percent (or a greater percentage if specified elsewhere in the contract) of the total original contract price, excluding any specialty items designated by the State. Specialty items may be performed by subcontract and the amount of any such specialty items so performed may be deducted from the total original contract price before computing the amount of work required to be performed by the contractor's own organization (23 CFR Part 635).

a. "Its own organization" shall be construed to include only workers employed and paid directly by the prime contractor and equipment owned or rented by the prime contractor, with or without operators. Such term does not include employees or equipment of a subcontractor, assignee, or agent of the prime contractor.

b. "Specialty Items" shall be construed to be limited to work that requires highly specialized knowledge, abilities, or equipment not ordinarily available in the type of contracting organizations qualified and expected to bid on the contract as a whole and in general are to be limited to minor components of the overall contract.

2. The contract amount upon which the requirement set forth in paragraph 1 of this Section VII is computed includes the cost of materials and manufactured products which are to be purchased or produced by the contractor under the contract provisions.

3. The contractor shall furnish (a) a competent superintendent or supervisor who is employed by the firm, has full authority to direct performance of the work in accordance with the contract requirements, and is in charge of all construction operations (regardless of who performs the work) and (b) such other of its own organizational resources (supervision, management, and engineering services) as the SHA contracting officer determines is necessary to assure the performance of the contract.

4. No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the SHA contracting officer, or authorized representative, and such consent when given shall not be construed to relieve the contractor of any responsibility for the fulfillment of the contract. Written consent will be given only after the SHA has assured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract.

VIII. SAFETY: ACCIDENT PREVENTION

1. In the performance of this contract the contractor shall comply with all applicable Federal, State, and local laws governing safety, health, and sanitation (23 CFR Part 635). The contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions as it determines, or as the SHA contracting officer may determine, to be reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.

2. It is a condition of this contract, and shall be made a condition of each subcontract entered into pursuant to this contract, that the contractor and any subcontractor shall not require any laborer or mechanic employed in performance of the contract to work in surroundings or under conditions which are unsanitary, hazardous, or dangerous to his/her health or safety, as determined under construction safety and health standards [Title 29, Code of Federal Regulations, Part 1926 (formerly Part 1518) as may be revised] promulgated by the Secretary of Labor, in accordance with Section 107 of the Contract Work Hours and Safety Standards Act (83 Stat. 96).

IX. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS

In order to assure high quality and durable construction in conformity with approved plans and specifications and a high degree of reliability on statements and representations made by engineers, contractors, suppliers, and workers on Federal-aid highway projects, it is essential that all persons concerned with the project perform their functions as carefully, thoroughly, and honestly as possible. Willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of Federal law. To prevent any misunderstanding regarding the seriousness of these and similar acts, the following notice shall be posted on each Federal-aid highway project (23 CFR Part 635) in one or more places where it is readily available to all persons concerned with the project:

• • • • •

NOTICE TO ALL PERSONNEL ENGAGED ON FEDERAL-AID HIGHWAY PROJECTS

Title 18, United States Code, Section 1020, reads as follows:

"Whoever, being an officer, agent, or employee of the United States, or of any State or Territory, or whoever, whether a person, association, firm, or corporation, knowingly makes any false statement, false representation, or false report as to the character, quality, quantity, or cost of the material used or to be used, or the quantity or quality of the work performed or to be performed, or the costs thereof in connection with the submission of plans, maps, specifications, contracts, or costs of construction on any highway or related project submitted for approval to the Secretary of Transportation; or,

"Whoever knowingly makes any false statement, false representation, false report or false claim with respect to the character, quality, quantity, or cost of any work performed or to be performed, or materials furnished or to be furnished, in connection with the construction of any highway or related project approved by the Secretary of Transportation; or

"Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-Aid Roads Act approved July 1, 1916, (39 Stat. 355), as amended and supplemented;

"Shall be fined not more than $10,000 or imprisoned not more than 5 years, or both."

* * * * *

X. IMPLEMENTATION OF CLEAN AIR ACT AND FEDERAL WATER POLLUTION CONTROL ACT

(Applicable Federal-aid construction contracts and related subcontracts exceeding $100,000.)

By submission of this bid, or the execution of this contract or subcontract, as appropriate, the bidder, Federal-aid construction contractor, or subcontractor, as appropriate, will be deemed to have stipulated as follows:

1. That any facility that is or will be utilized in the performance of this contract, unless such contract is exempt under the Clean Air Act, as amended (42 U.S.C. 1857 et seq., as amended by Pub. L. 91-604), and under the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251, et seq., as amended by Pub. L. 92-500), Executive Order 11738, and regulations in implementation thereof (40 CFR Part 15) is not listed, on the date of contract award, on the U.S. Environmental Protection Agency (EPA) List of Violating Facilities pursuant to 40 CFR 15.20.

2. That the firm agrees to comply and remain in compliance with all the requirements of Section 114 of the Clean Air Act and Section 308 of the Federal Water Pollution Control Act and all regulations and guidelines listed thereunder.

3. That the firm shall promptly notify the SHA of the receipt of any communication from the Director, Office of Federal Activities, EPA, indicating that a facility that is or will be utilized for the contract is under consideration to be listed on the EPA List of Violating Facilities.

4. That the firm agrees to include or cause to be included the requirements of paragraphs 1 through 4 of this Section X in every nonexempt subcontract, and further agrees to take such action as the government may direct as a means of enforcing such requirements.

* * * * *

XI. CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION—LOWER TIER COVERED TRANSACTIONS

(Applicable to all subcontractors, material suppliers, vendor and other lower tier participants.)

1. Instructions for Certification:

a. By signing and submitting this proposal, the prospective lower tier participant is providing the certification set out below.

b. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

c. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

d. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations.

e. The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.

f. The prospective lower tier participant further agrees by submitting this proposal that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion—Lower Tier Covered Transaction," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

g. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that it is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the Nonprocurement List.

h. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

i. Except for transactions authorized under paragraph e of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

2. Certification Regarding Debarment, Suspensi..., Ineligibility and Voluntary Exclusion—Lower Tier Covered Transactions:

a. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

b. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

ARIZONA DEPARTMENT OF TRANSPORTATIO

HIGHWAYS DIVISION

206 South Seventeenth Avenue Phoenix, Arizona 85007

ROSE MOFFORD
Governor

CHARLES L. MILLER
Director

CONTRACTS & SPECIFICATIONS SERVICES
1651 West Jackson St., Room 121F
Phoenix, AZ 85007

THOMAS A. E
State Eng

January 23, 1990

ADDENDUM

(1)

TO ALL CONTRACTORS AND OTHERS INTERESTED IN PROJECT
IR-8-2(91)
008 PN 147 H0013 04 C
YUMA - CASA GRANDE HIGHWAY (I-8)
(County Line - Stanfield Rd. T.I. EB)
SCHEDULED FOR BID OPENING ON
FRIDAY, FEBRUARY 16, 1990 AT 11:00 A.M.

REVISIONS AND ADDITIONS TO THE ADVERTISEMENT FOR BIDS:

Description of the proposed work is modified to add:

The contractor shall be aware that eleven test sections (SPS-5) are to be constructed between Mileposts 159.02 and 160.87. These test sections are part of the Strategic Highway Research Program (SHRP). As such, they will require extraordinary compliance with the requirements of the Standard Specifications and the Special Provisions to ensure the highest level of construction quality possible.

The Construction Supervisor is revised to read:

Construction Supervisor: Mike Myers (602) 836-2501.

REVISIONS AND ADDITIONS TO THE SPECIAL PROVISIONS:

PROPOSED WORK: on sheet 1 of 119 is modified to add:

The contractor shall be aware that eleven test sections (SPS-5) are to be constructed between Mileposts 159.02 and 160.87. These test sections are part of the Strategic Highway Research Program (SHRP). As such, they will require extraordinary compliance with the requirements of the Standard Specifications and the Special Provisions to ensure the highest level of construction quality possible.

GENERAL REQUIREMENTS: on sheet 25 of 119 is modified to add:

The recycled asphaltic concrete and asphaltic concrete (End Product) placed within the SHRP test sections shall utilize the same mix designs as specified in Sections 408 and 416 of the Special Provisions and the Standard Specifications. The only deviation will be that nuclear density gauge testing will be substituted for the ten sample cores specified in Subsections 408-7.08 and 416-7.08 within the SHRP test sections. The Department will conduct the nuclear gauge testing at the random locations designated for the sample cores. No cores will be retrieved from the SHRP sections. Cores required to calibrate nuclear density gauges will be obtained in transition sections between the SHRP test sections. The ADOT Research Section will approve all Core locations in advance. Nuclear density testing will be performed in accordance with Arizona Test Method 412.

The quantities shown in the bidding schedule for Item 4160002 - "Asphaltic concrete (3/4" Mix)(End Product) includes 2000 tons of asphalt concrete to be used in the first day the contractor starts milling the existing roadway. Once this quantity of asphalt concrete has been produced and the contractor has satisfactorily demonstrated proper compaction procedures, the contractor shall mill test sections 1, 7, and 9 within the SHRP test sections and replace the milled asphaltic material with asphalt concrete. This shall occur prior to switching to the recycled asphaltic concrete material.

Once the contractor has satisfactorily produced and placed at least 4000 tons of recycled asphaltic concrete and prior to changing back to asphaltic concrete (End Product) production the contractor shall construct test sections 3, 4, 5, 6, and 9.

The contractor may mill the A.C.F.C. from any SHRP test section at his convenience.

This plies to ctions ine after ing recycle

Once the contractor has satisfactorily produced and placed at least 4000 tons of asphaltic concrete (End Product) during overlay placement, the contractor shall construct test sections 1, 2, 7, and 8.

The contractor's operation shall be such that no transverse construction joints will occur within the SHRP sections and all placement and compaction procedures shall be well established prior to placement of the SHRP test sections. Adjoining lifts shall utilize butt joints produced by milling the tapers until a two-inch vertical face is produced. All asphaltic concrete vertical faces shall receive a light application of tack coat.

The asphaltic concrete (Modified)(Asphalt Rubber) test section (No. 10) shall be constructed after all other test sections are completed. The asphalt rubber test section shall be constructed by first overlaying the passing lane and inside shoulder followed by the travel lane and outside shoulder.

All the SHRP test sections shall be constructed within the sa construction season. Except for test section 10, the asphalt concrete pavement material shall be the same for both the SHRP te sections and the mainline.

SECTION 103 - AWARD AND EXECUTION OF CONTRACT: (AWARD103, 450/ 12/30/88) on sheet 31 of 119 is revised to read:

(AWARD103, 450/o, 12/15/8

SECTION 103 - AWARD AND EXECUTION OF CONTRACT:

103.02 Award of Contract: the first paragraph of th Standard Specifications is modified to add:

When a contract is funded, either wholly or in part, by federa funds, an award of contract may be made contingent upon th successful bidder obtaining an appropriate license from the Stat Registrar of Contractors, in accordance with Arizona Revise Statutes 32-1101 through 32-1170.03. The license must be obtained within 60 calendar days following opening of bid proposals. N adjustment in proposed bid prices or damages for delay will b allowed as a result of any delay caused by the lack of a appropriate license.

Failure to acquire the necessary licensing within the specifie period of time shall result in either award to the next lowes responsible bidder, or re-advertisement of the contract, as may b in the best interests of the Department.

Licensing information is available from:

Registrar of Contractors
800 W. Washington
6th Floor
Phoenix, AZ 85007
Phone: (602) 542-1502

ITEM 4060053- Asphaltic Concrete (MODIFIED)(ASPHALT RUBBER) o sheet 50 through sheet 55 of 119 is revised to read:

Description:

The work under this item, hereinafter asphaltic concrete, shal consist of furnishing all materials, mixing at a plant, hauling, an placing a mixture of an aggregate and bituminous material to form pavement course or to be used for other specified purposes, i accordance with the details shown on the project plans, th requirements of these Special Provisions, and as directed by th Engineer.

The contractor shall be responsible for all adjustments to hi equipment necessary to properly accommodate the use of asphal rubber as a bituminous material.

Materials:

Mineral Aggregate:

There is no Department-furnished source of mineral aggregate. Th contractor shall provide a source in accordance with th requirements of Section 1001 of the Standard Specifications.

Mineral aggregate shall conform to the following requirements whe tested in accordance with the applicable test methods.

Mineral Aggregate Characteristics	Test Method	Requirement
Combined Bulk Specific Gravity	AASHTO T 85 Arizona Test Method 211	2.35 - 2.85
Combined Water Absorption	AASHTO T 85 Arizona Test Method 211	0 - 2.5
Sand Equivalent	AASHTO T 176	Minimum 55
Crushed Faces	Arizona Test Method 212	Minimum 70%
Abrasion	AASHTO T 96	100 Rev., Max 9% 500 Rev., Max 40%

The mix design grading limits for mineral aggregate shall be a follows:

Proposal OK

Sieve Size	Percent Passing
3/4	100
1/2 inch	
3/8 inch	75 - 90
1/4 inch	40 - 60
No. 8	15 - 25
No. 40	5 - 15
No. 200	0 - 2.5

Change

During the production of asphaltic concrete, mineral aggregat gradation shall be tested for acceptance in accordance with th requirements of Subsection 406-9.03(A).

Bituminous Material:

Bituminous material shall be asphalt-rubber (vulcanized) and shal conform to the requirements of Section 1009 of the Standar Specifications, except for the following:

The rubber shall conform to the following gradation:

Sieve Size	Percent Passing
No. 10	100
No. 16	75 - 100
No. 30	25 - 100
No. 50	0 - 45
No. 100	0 - 10
No. 200	0 - 5

No change

The asphalt rubber binder shall conform to the following requirements:

Parameter	Requirement
Viscosity, Haake, 350F	1500 - 4000 cp.
Cone Penetration, 77F (ASTM D1191)	20 min.
Softening Point, F (ASTM D36)	125F min. $70
Resilience, 77F (ASTM D3407)	15 % min.

During the production of asphaltic concrete, the contractor shall maintain on the site a nuclear asphalt content gauge calibrated on the material being tested in accordance with the gauge manufacturer's recommendations. Asphaltic concrete asphalt rubber content shall be measured by the contractor by means of the nuclear asphalt content gauge a minimum of four times per full shift. Production of asphaltic concrete shall cease immediately and the plant recalibrated if the Engineer determines the percent of bituminous material has varied by an amount greater than 0.5 percent from the amount directed by the Engineer. During the production of asphalt rubber, the contractor shall maintain on site equipment necessary to measure the viscosity of the mixture. The mixture shall be maintained between 1500 and 4000 centipoise at 350F. Mixture viscosity shall be checked at the direction of the Engineer.

0.5%

X

For comparative purposes, quantities shown in the bidding schedule have been calculated based on the following Data:

	Asphaltic concrete (Modified)(Asphalt Rubber)
Unit Weight, Pounds Per Cubic Foot	146.00
Percent, Asphalt Rubber	6.5

Post Truck

Blending Mill

Mix Design Proposal:

A fifty pound sample from each stockpile of mineral aggregate shall be furnished to the Engineer, along with a letter from the contractor explaining in detail his proposed methods of producing mineral aggregate, including the expected wasting, washing, blending, proportioning, etc., to produce asphaltic concrete that meets the requirements and gradation as specified herein and any special or limiting conditions that he may propose.

Along with these aggregate samples the ~~contractor~~ shall furnish a minimum 10 pound sample of the granulated rubber proposed for use, one gallon of AC-10 asphalt cement from the intended supplier, and two gallons of the proposed mixture of asphalt and rubber.

The Department will, within 10 working days of receipt of all samples in the Central Laboratory, provide the contractor with the percentage of bituminous material to be used in the mix, the percent of aggregate material passing each required sieve, and any special or limiting conditions for the use of the mix.

Construction Requirements:

The asphaltic concrete shall be constructed in accordance with the requirements of Subsection 406-10 and the following modifications and additions:

General:

The surface upon which the asphaltic concrete is to be placed shall be cleaned of all objectionable material and tacked with a light coat of asphalt cement. The cleaning of the surface, the tacking of the surface, and amount of bituminous material used shall be as directed by and acceptable to the Engineer.

Just prior to being placed, the asphaltic concrete shall be in a thoroughly mixed condition, free of lumps and crusts, and be in a free flowing, workable condition.

Proportioning:

The asphalt cement stall be modified by the addition of a minimum 20 percent of granulated rubber, by weight of the asphalt unle otherwise approved by the Department's Central Laboratory.

The asphalt cement and rubber shall be combined prior to t incorporation into the asphaltic concrete for a period of at lea one hour; however, the mixture of asphalt cement and rubber shou not be held at temperatures over 350 degrees F. for a period ov 10 hours. The temperature of the asphalt cement shall be betwe 350 and 400 degrees F. at the time of the addition of the granulat rubber. Temperature of the asphalt rubber mixture shall maintained between 325 and 375 degrees F. during the one ho reaction period.

Compaction:

Asphaltic concrete shall be placed only when the temperature of t surface on which the asphaltic concrete is to be placed is at lea 65 degrees F.

The temperature of asphaltic concrete just prior to compaction sha be at least 275 degrees F.

Compaction shall be accomplished by the following sequence a coverage of rollers.

A minimum of two (2) Static Steel Wheel rollers and two (2 vibratory steel wheel rollers shall be provided. The drums shall b of sufficient width that when staggered, two (2) rollers can cove the entire width of the ribbon with one (1) pass. The two vibrato rollers shall be used for initial breakdown and be maintained r more than 150 feet behind the paving machine. The remaining tw static rollers shall follow as closely behind the initial breakdow as possible. As many passes as is possible shall be made with th second set of rollers before the temperature of the asphalti concrete falls below 220 degrees F.

Start in passing lane

Steel Wheel compactors shall weigh not less than eight tons. Th rollers shall be self-propelled and shall be operated with the driv wheel in the forward position. Vibratory rollers shall be used i the mode required by the Engineer. All rollers shall be equippe with pads and a watering system to prevent sticking of the asphalti concrete mix to the steel wheels. Steel wheel compactors shall no use the vibratory mode for courses of 1 1/2 inches or less i nominal thickness.

In order to achieve, as far as practicable, a continuous operation the speed of the paving machine shall be coordinated with th production of the plant. At no time shall the paving machine b stopped for more than three minutes. In the event a three minute o longer delay occurs the paving machine shall be pulled away from th mat in order for the rollers to compact this

The rollers steel wheels shall be wetted with water or, if necessary, soapy water to prevent mix pick-up during rolling. The Engineer may change the number of coverages or sequence if, in his judgement, the change is necessary to prevent picking up of the asphaltic concrete.

Asphaltic concrete will be accepted complete in place, if, in the judgement of the Engineer, the asphaltic concrete reasonably conforms to the requirements specified herein. Asphaltic concrete that is not acceptable and is rejected shall be replaced to the satisfaction of the Engineer and at no expense to the Department.

Method of Measurement:

Asphaltic concrete will be measured by the ton for the mixture actually used, which will include the weight of mineral aggregate, bituminous material, and any necessary blending material. Measurement will include any weight used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

Asphalt-rubber material will be measured by the ton in accordance with the requirements of Section 1009 of the Standard Specifications.

BASIS OF PAYMENT:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price per ton for the bituminous mixture, which price shall be full compensation for the work, complete in place, as specified herein.

Payment for the asphalt-rubber will be made by the ton of the mixture, including asphalt cement and granulated rubber.

DAVID R. ALLOCCO
Engineer-Manager
Contracts & Specifications Services

DRA:TK:jkg:jj:2232v

ARIZONA DEPARTMENT OF TRANSPORTATION

ADVERTISEMENT FOR BIDS

BID OPENING: FRIDAY, FEBRUARY 16, 1990 AT 11:00 A.M.

PROJECT NO.: IR-8-2(91)
TRACS NO.: 008 PN 147 H0013 04 C
TERMINI: YUMA - CASA GRANDE HIGHWAY (I-8)
LOCATION: (County Line - Stanfield Rd. T.I. EB)

ROUTE NO.	MILEPOST	DISTRICT	ITEM NO.
I-8	147.60 to 160.87	II	104

The location and description of the proposed work and th representative items and approximate quantities are as follows:

The proposed work is located in Pinal County, on Interstate Rou 8 (Eastbound) beginning at Milepost 147.60 and extending in a wester direction to Milepost 160.87 approximately 17 miles southwest of t City of Casa Grande for a distance of approximately 13.27 miles a consists of removal of asphaltic concrete pavement, embankment cu and trees; grading roadway for pavement and furnishing all materia and placing asphaltic concrete courses; furnishing and constructi embankment curb, guardrail, breakaway cable terminals, and concre barriers; furnishing and applying thermoplastic pavement marking; a other incidental work.

Removal of Asphaltic Concrete Pavement (Milling)	Sq.Yd.	231,460
Roadway Excavation	Cu.Yd.	206
Grading Roadway for Pavement	Sq.Yd.	6,567
Bituminous Material	Ton	4,383
Asphalt Rubber Material	Ton	22
Asphaltic Concrete (Modified)(A.R.)	Ton	360
Asphaltic Concrete (End Product)	Ton	52,414
Asphaltic Concrete Friction Course	Ton	5,994
Recycled Asphaltic Concrete	Ton	35,63
Guardrail, W Beam Single Face	L.Ft.	17,67
Reconstruct Guard Rail	L.Ft.	14,11
Concrete Barrier (Median)	L.Ft.	2,60
Pavement Marking (Thermoplastic)	L.Ft.	191,00
Provide Trainees with ON-The Job Training	Hour	1,10
Construction Surveying and Layout	L.Sum	

The number of working days specified for the completion of work is 130.

The Arizona Department of Transportation hereby notifies bidders that pursuant to this advertisement for bids, Disadvan Business Enterprises will be afforded full opportunity to submit in response to this solicitation and will not be discriminated ag on the grounds of race, color, sex, or national origi consideration for an award.

The minimum goals for participation by Disadvantaged Bus Enterprises in the work, as a percentage of the total amount shall be 12.0.

Project plans, specifications, and proposal pamphlets may be purchased from Contracts and Specifications Services, 1651 W. Jackson, Room 121F, Phoenix, AZ 85007, (602) 255-7221. Plans and bidding documents should be available for sale to bidders within one week following the advertisement for bids. The cost is $24.00, payable at time of order by cash, check or money order. Please indicate whether a bid proposal package or a subcontractor/supplier set is desired. Checks should be made payable to the Arizona Department of Transportation. No refund will be made for plans and specifications returned. We cannot guarantee mail delivery.

Cross sections and/or earthwork quantity sheets, if available, may be ordered from the Control Desk of Highway Plans Services at 255-8667. Orders must be placed at least five days prior to bid opening to insure availability. Documents may be picked up and paid for at Contracts & Specifications Services.

No contracting firm will be issued a proposal pamphlet until it has become prequalified. The Application for Contractor Prequalification shall be filed at least 15 calendar days prior to the bid opening date. The Application may be obtained from Contracts and Specifications Services.

No award will be made to any contractor who is not a duly licensed contractor in accordance with Arizona Revised Statutes 32-1101 through 32-1170.03.

All labor employed on this project shall be paid in accordance with the minimum wage rates shown in the General Wage Decision No. AZ89-2. These rates have been determined in accordance with the requirements of the law and issued by the Secretary of Labor for this project. The wage scale is on file in Contracts and Specifications Services and copies may be obtained at all reasonable times.

A proposal guaranty in the form of either a certified or a cashier's check made payable to the State Treasurer of Arizona for not less than five percent of the amount of the bid or in the form of a surety (bid) bond for five percent of the amount of the bid shall accompany the proposal.

Surety (bid) bonds will be accepted only on the form provided by the Department and only from corporate sureties authorized to do business in Arizona.

APPENDIX C

TABULATION OF BIDS FOR PROJECT IR-8-2(91)

RECEIVED

APR 30 1990

ARIZONA TRANSPORTATION RESEARCH CENTER

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION
CONTRACTS AND SPECIFICATIONS SERVICES

COMPLETION DATE
130 WORKING DAYS

TABULATION OF BIDS

TK/jkg

The proposed work is located in Pinal County, on Interstate Route 8 (Eastbound) beginning at Milepost 147.60 and extending in a westerly direction to Milepost 160.87 approximately 17 miles southwest of the City of Casa Grande for a distance of approximately 13.27 miles and consists of removal of asphaltic concrete pavement, embankment curb and trees; grading roadway for pavement and furnishing all materials and placing asphaltic concrete courses; furnishing and constructing embankment curb, guardrail, breakaway cable terminals, and concrete barriers; furnishing and applying thermoplastic pavement marking; and other incidental work.

BID RESULTS

IR-8-2(91) 008 PN 147 H0013 04 C YUMA - CASA GRANDE HIGHWAY (I-8) (County Line - Stanfield Rd. T.I. EB)

District #II Item #104

Engineer: TALAL KAMAL Prequalification: YES BID OPENING: FEBRUARY 16, 1990

	AMOUNT	CONTRACTOR	ADDRESS OF CONTRACTOR			
1.	$3,126,124.20	CORN CONSTRUCTION CO.	2701 MILES ROAD S.E., STE. 175	ALBUQUERQUE	NM	87016
2.	3,267,232.30	JWJ CONTRACTING COMPANY, INC.	4525 EAST UNIVERSITY DR.	PHOENIX	AZ	85034
3.	3,284,380.20	THE ASHTON COMPANY, INC.	2727 S. COUNTRY CLUB	TUCSON	AZ	85713
4.	3,306,643.50	FNF CONSTRUCTION, INC.	1921 S. ALMA SCHOOL, STE. 101	MESA	AZ	85210
5.	3,399,097.00	SUNDT CORP	P.O. BOX 26685	TUCSON	AZ	85726
6.	3,410,362.00	DEPARTMENT				
7.	3,410,741.50	THE TANNER COMPANIES	P.O. BOX 52151	PHOENIX	AZ	85072
8.	3,527,357.20	STAKER PAVING & CONST. CO., INC.	1000 W. CENTER ST.	NO. SALT LAKE	UT	84054
9.	3,560,919.00	JAMES L FANN CONTRACTING, INC.	P.O. BOX 4356	PRESCOTT	AZ	86302
10.	4,174,625.50	JAMES HAMILTON CONSTRUCTION CO.	P.O. DRAWER 1287	SILVER CITY	NM	88062
NON-RESPONSIVE		GIBBONS & REED COMPANY	BID NOT READ AND DECLARED NON-RESPONSIVE FOR FAILURE TO SIGN PROPOSAL.			

LOW BIDDER IS 8.3% UNDER DEPARTMENT ESTIMATE (Difference = $284,237.80)

* TABULATION OF BIDS *

PROJ.NO: IR 8-2(91)* * * CONTRACT NO.: 89104
TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION		QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
2020009	CU.YD.	REMOVAL OF STRUCTURAL CONCRETE					
	TOTAL BID RANK		DEPARTMENT ESTIMATE	178	300.00	53,400.00	
	1		CORN CONSTRUCTION CO		360.00	64,080.00	+20%
	2		JWJ CONTRACTING CO		200.00	35,600.00	-33%
	3		THE ASHTON CO INC		160.00	28,480.00	-47%
	4		FNF CONSTRUCTION		250.00	44,500.00	-17%
	5		SUNDT CORP.		165.00	29,370.00	-45%
	6		THE TANNER COMPANIES		200.00	35,600.00	-33%
	7		STAKER PAVING & CONSTRUCTION		260.00	46,280.00	-13%
	8		JAMES L FANN CONTRAC		300.00	53,400.00	+0%
	9		JAMES HAMILTON		300.00	53,400.00	+0%
2020019	L.FT.	REMOVAL OF EMBANKMENT CURB					
	TOTAL BID RANK		DEPARTMENT ESTIMATE	5,990	1.30	7,787.00	
	1		CORN CONSTRUCTION CO		1.00	5,990.00	-23%
	2		JWJ CONTRACTING CO		2.00	11,980.00	+54%
	3		THE ASHTON CO INC		1.30	7,787.00	+0%
	4		FNF CONSTRUCTION		1.25	7,487.50	-4%
	5		SUNDT CORP.		.50	2,995.00	-62%
	6		THE TANNER COMPANIES		1.50	8,985.00	+15%
	7		STAKER PAVING & CONSTRUCTION		2.00	11,980.00	+54%
	8		JAMES L FANN CONTRAC		2.00	11,980.00	+54%
	9		JAMES HAMILTON		1.00	5,990.00	-23%
2020029	SQ.YD.	REMOVAL OF ASPHALTIC CONCRETE PAVEMENT					
	TOTAL BID RANK		DEPARTMENT ESTIMATE	231,460	.75	173,595.00	
	1		CORN CONSTRUCTION CO		.70	162,022.00	-7%
	2		JWJ CONTRACTING CO		.80	185,168.00	+7%
	3		THE ASHTON CO INC		.80	185,168.00	+7%
	4		FNF CONSTRUCTION		1.00	231,460.00	+33%
	5		SUNDT CORP.		.75	173,595.00	+0%
	6		THE TANNER COMPANIES		.90	208,314.00	+20%
	7		STAKER PAVING & CONSTRUCTION		.80	185,168.00	+7%
	8		JAMES L FANN CONTRAC		.80	185,168.00	+7%
	9		JAMES HAMILTON		1.28	296,268.80	+71%

ARIZONA DEPARTMENT OF TRANSPORTATION
CONTRACTS AND SPECIFICATIONS SERVICES

* TABULATION OF BIDS *

PROJ.NO: IR 8-2(91)* CONTRACT NO.: 89104

TRACS ||||| || | ROUTE |||| MILEPOST ||| COUNTY ||

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION	QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
2020037	EACH	REMOVE AND SALVAGE CATTLE GUARDS				
	TOTAL BID RANK	DEPARTMENT ESTIMATE	1	800.00	800.00	
	1	CORN CONSTRUCTION CO		1,800.00	1,800.00	+125%
	2	JWJ CONTRACTING CO		2,000.00	2,000.00	+150%
	3	THE ASHTON CO INC		1,500.00	1,500.00	+87%
	4	FNF CONSTRUCTION		800.00	800.00	+0%
	5	SUNDT CORP.		2,000.00	2,000.00	+150%
	6	THE TANNER COMPANIES		1,500.00	1,500.00	+87%
	7	STAKER PAVING & CONSTRUCTION		2,000.00	2,000.00	+150%
	8	JAMES L FANN CONTRAC		2,000.00	2,000.00	+150%
	9	JAMES HAMILTON		1,000.00	1,000.00	+25%
2020065	EACH	REMOVAL OF TREES				
	TOTAL BID RANK	DEPARTMENT ESTIMATE	70	100.00	7,000.00	
	1	CORN CONSTRUCTION CO		100.00	7,000.00	+0%
	2	JWJ CONTRACTING CO		50.00	3,500.00	-50%
	3	THE ASHTON CO INC		50.00	3,500.00	-50%
	4	FNF CONSTRUCTION		100.00	7,000.00	+0%
	5	SUNDT CORP.		100.00	7,000.00	+0%
	6	THE TANNER COMPANIES		100.00	7,000.00	+0%
	7	STAKER PAVING & CONSTRUCTION		70.00	4,900.00	-30%
	8	JAMES L FANN CONTRAC		100.00	7,000.00	+0%
	9	JAMES HAMILTON		300.00	21,000.00	+200%
2020072	L.FT.	REMOVE AND SALVAGE GUARD RAIL				
	TOTAL BID RANK	DEPARTMENT ESTIMATE	38	4.00	152.00	
	1	CORN CONSTRUCTION CO		8.00	304.00	+100%
	2	JWJ CONTRACTING CO		6.00	228.00	+50%
	3	THE ASHTON CO INC		50.00	1,900.00	+1150%
	4	FNF CONSTRUCTION		2.50	95.00	-37%
	5	SUNDT CORP.		5.00	190.00	+25%
	6	THE TANNER COMPANIES		10.00	380.00	+150%
	7	STAKER PAVING & CONSTRUCTION		5.85	222.30	+46%
	8	JAMES L FANN CONTRAC		5.00	190.00	+25%
	9	JAMES HAMILTON		3.00	114.00	-25%

*** TABULATION OF BIDS ***

PROJ.NO: IR 8-2(91)* CONTRACT NO.: 89104
TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION		QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
2020201	L.FT.	SAW CUTTING					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	3,092	1.00	3,092.00	
		1	CORN CONSTRUCTION CO		1.00	3,092.00	+0%
		2	JWJ CONTRACTING CO		.50	1,546.00	-50%
		3	THE ASHTON CO INC		1.00	3,092.00	+0%
		4	FNF CONSTRUCTION		.50	1,546.00	-50%
		5	SUNDT CORP.		1.00	3,092.00	+0%
		6	THE TANNER COMPANIES		.60	1,855.20	-40%
		7	STAKER PAVING & CONSTRUCTION		.70	2,164.40	-30%
		8	JAMES L FANN CONTRAC		1.00	3,092.00	+0%
		9	JAMES HAMILTON		.70	2,164.40	-30%
2030301	CU.YD.	ROADWAY EXCAVATION					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	206	10.00	2,060.00	
		1	CORN CONSTRUCTION CO		20.00	4,120.00	+100%
		2	JWJ CONTRACTING CO		10.00	2,060.00	+0%
		3	THE ASHTON CO INC		5.00	1,030.00	-50%
		4	FNF CONSTRUCTION		15.00	3,090.00	+50%
		5	SUNDT CORP.		8.00	1,648.00	-20%
		6	THE TANNER COMPANIES		10.00	2,060.00	+0%
		7	STAKER PAVING & CONSTRUCTION		14.50	2,987.00	+45%
		8	JAMES L FANN CONTRAC		8.00	1,648.00	-20%
		9	JAMES HAMILTON		10.00	2,060.00	+0%
2030901	CU.YD.	BORROW					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	3,732	7.00	26,124.00	
		1	CORN CONSTRUCTION CO		9.50	35,454.00	+36%
		2	JWJ CONTRACTING CO		6.00	22,392.00	-14%
		3	THE ASHTON CO INC		10.00	37,320.00	+43%
		4	FNF CONSTRUCTION		10.00	37,320.00	+43%
		5	SUNDT CORP.		10.00	37,320.00	+43%
		6	THE TANNER COMPANIES		15.00	55,980.00	+114%
		7	STAKER PAVING & CONSTRUCTION		8.80	32,841.60	+26%
		8	JAMES L FANN CONTRAC		10.00	37,320.00	+43%
		9	JAMES HAMILTON		4.00	14,928.00	-43%

ARIZONA DEPARTMENT OF TRANSPORTATION
CONTRACTS AND SPECIFICATIONS SERVICES

*** TABULATION OF BIDS ***

PROJ.NO: IR 8-2(91)*

CONTRACT NO.: 89104

TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION		QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
2031001	HOUR	COMPACTION OF SHOULDER MATERIAL					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	210	70.00	14,700.00	
		1	CORN CONSTRUCTION CO		45.00	9,450.00	-36%
		2	JWJ CONTRACTING CO		75.00	15,750.00	+7%
		3	THE ASHTON CO INC		70.00	14,700.00	+0%
		4	FNF CONSTRUCTION		10.00	2,100.00	-86%
		5	SUNDT CORP.		75.00	15,750.00	+7%
		6	THE TANNER COMPANIES		70.00	14,700.00	+0%
		7	STAKER PAVING & CONSTRUCTION		60.00	12,600.00	-14%
		8	JAMES L FANN CONTRAC		65.00	13,650.00	-7%
		9	JAMES HAMILTON		20.00	4,200.00	-71%
2050001	SQ.YD.	GRADING ROADWAY FOR PAVEMENT					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	8,877	4.00	35,508.00	
		1	CORN CONSTRUCTION CO		3.50	31,069.50	-12%
		2	JWJ CONTRACTING CO		1.00	8,877.00	-75%
		3	THE ASHTON CO INC		.50	4,438.50	-87%
		4	FNF CONSTRUCTION		1.00	8,877.00	-75%
		5	SUNDT CORP.		1.00	8,877.00	-75%
		6	THE TANNER COMPANIES		.60	5,326.20	-85%
		7	STAKER PAVING & CONSTRUCTION		2.00	17,754.00	-50%
		8	JAMES L FANN CONTRAC		1.00	8,877.00	-75%
		9	JAMES HAMILTON		1.80	15,978.60	-55%
2070001	M.GAL.	DUST PALLIATIVE					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	1,600	8.00	12,800.00	
		1	CORN CONSTRUCTION CO		8.00	12,800.00	+0%
		2	JWJ CONTRACTING CO		8.00	12,800.00	+0%
		3	THE ASHTON CO INC		8.00	12,800.00	+0%
		4	FNF CONSTRUCTION		8.00	12,800.00	+0%
		5	SUNDT CORP.		8.00	12,800.00	+0%
		6	THE TANNER COMPANIES		8.00	12,800.00	+0%
		7	STAKER PAVING & CONSTRUCTION		8.00	12,800.00	+0%
		8	JAMES L FANN CONTRAC		8.00	12,800.00	+0%
		9	JAMES HAMILTON		8.00	12,800.00	+0%

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* TABULATION OF BIDS *
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PROJ.NO: IR 8-2(91)* * *
TRACS ||||| || | ROUTE |||| MILEPOST ||| COUNTY || CONTRACT NO.: 89104

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION		QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
4040020	TON	ASPHALT CEMENT (AC-20)					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	1,204	130.00	156,520.00	
		1	CORN CONSTRUCTION CO		128.00	154,112.00	-2%
		2	JWJ CONTRACTING CO		130.00	156,520.00	+0%
		3	THE ASHTON CO INC		128.00	154,112.00	-2%
		4	FNF CONSTRUCTION		125.00	150,500.00	-4%
		5	SUNDT CORP.		127.00	152,908.00	-2%
		6	THE TANNER COMPANIES		150.00	180,600.00	+15%
		7	STAKER PAVING & CONSTRUCTION		140.00	168,560.00	+8%
		8	JAMES L FANN CONTRAC		130.00	156,520.00	+0%
		9	JAMES HAMILTON		124.50	149,898.00	-4%

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION		QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
4040029	TON	ASPHALT CEMENT (AC-20) (FOR ACFC)					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	360	130.00	46,800.00	
		1	CORN CONSTRUCTION CO		128.00	46,080.00	-2%
		2	JWJ CONTRACTING CO		130.00	46,800.00	+0%
		3	THE ASHTON CO INC		128.00	46,080.00	-2%
		4	FNF CONSTRUCTION		125.00	45,000.00	-4%
		5	SUNDT CORP.		127.00	45,720.00	-2%
		6	THE TANNER COMPANIES		150.00	54,000.00	+15%
		7	STAKER PAVING & CONSTRUCTION		140.00	50,400.00	+8%
		8	JAMES L FANN CONTRAC		130.00	46,800.00	+0%
		9	JAMES HAMILTON		140.00	50,400.00	+8%

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION		QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
4040046	TON	ASPHALT CEMENT (AC-40) (FOR 3/4" MIX)					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	2,520	130.00	327,600.00	
		1	CORN CONSTRUCTION CO		128.00	322,560.00	-2%
		2	JWJ CONTRACTING CO		130.00	327,600.00	+0%
		3	THE ASHTON CO INC		128.00	322,560.00	-2%
		4	FNF CONSTRUCTION		125.00	315,000.00	-4%
		5	SUNDT CORP.		127.00	320,040.00	-2%
		6	THE TANNER COMPANIES		150.00	378,000.00	+15%
		7	STAKER PAVING & CONSTRUCTION		140.00	352,800.00	+8%
		8	JAMES L FANN CONTRAC		130.00	327,600.00	+0%
		9	JAMES HAMILTON		124.50	313,740.00	-4%

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* TABULATION OF BIDS *
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PROJ.NO: IR 8-2(91)* CONTRACT NO.: 89104
TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION		QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
4040111	TON	BITUMINOUS TACK COAT					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	254	380.00	96,520.00	
		1	CORN CONSTRUCTION CO		240.00	60,960.00	-37%
		2	JWJ CONTRACTING CO		400.00	101,600.00	+5%
		3	THE ASHTON CO INC		325.00	82,550.00	-14%
		4	FNF CONSTRUCTION		100.00	25,400.00	-74%
		5	SUNDT CORP.		300.00	76,200.00	-21%
		6	THE TANNER COMPANIES		550.00	139,700.00	+45%
		7	STAKER PAVING & CONSTRUCTION		160.00	40,640.00	-58%
		8	JAMES L FANN CONTRAC		400.00	101,600.00	+5%
		9	JAMES HAMILTON		430.00	109,220.00	+13%
4040126	TON	FOG COAT (ERA-25)					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	45	220.00	9,900.00	
		1	CORN CONSTRUCTION CO		230.00	10,350.00	+5%
		2	JWJ CONTRACTING CO		250.00	11,250.00	+14%
		3	THE ASHTON CO INC		300.00	13,500.00	+36%
		4	FNF CONSTRUCTION		200.00	9,000.00	-9%
		5	SUNDT CORP.		260.00	11,700.00	+18%
		6	THE TANNER COMPANIES		250.00	11,250.00	+14%
		7	STAKER PAVING & CONSTRUCTION		210.00	9,450.00	-5%
		8	JAMES L FANN CONTRAC		215.00	9,675.00	-2%
		9	JAMES HAMILTON		250.00	11,250.00	+14%
4040161	TON	ASPHALT RUBBER MATERIAL					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	22	485.00	10,670.00	
		1	CORN CONSTRUCTION CO		674.00	14,828.00	+39%
		2	JWJ CONTRACTING CO		700.00	15,400.00	+44%
		3	THE ASHTON CO INC		400.00	8,800.00	-18%
		4	FNF CONSTRUCTION		300.00	6,600.00	-38%
		5	SUNDT CORP.		700.00	15,400.00	+44%
		6	THE TANNER COMPANIES		600.00	13,200.00	+24%
		7	STAKER PAVING & CONSTRUCTION		690.00	15,180.00	+42%
		8	JAMES L FANN CONTRAC		780.00	17,160.00	+61%
		9	JAMES HAMILTON		830.00	18,260.00	+71%

* TABULATION OF BIDS *

PROJ.NO: IR 8-2(91)* CONTRACT NO.: 89104
TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION		QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
4040163	TON	BLOTTER MATERIAL					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	124	25.00	3,100.00	
		1	CORN CONSTRUCTION CO		20.00	2,480.00	-20%
		2	JWJ CONTRACTING CO		10.00	1,240.00	-60%
		3	THE ASHTON CO INC		5.00	620.00	-80%
		4	FNF CONSTRUCTION		10.00	1,240.00	-60%
		5	SUNDT CORP.		5.00	620.00	-80%
		6	THE TANNER COMPANIES		20.00	2,480.00	-20%
		7	STAKER PAVING & CONSTRUCTION		15.00	1,860.00	-40%
		8	JAMES L FANN CONTRAC		30.00	3,720.00	+20%
		9	JAMES HAMILTON		20.00	2,480.00	-20%
4060026	TON	MINERAL ADMIXTURE (FOR 3/4" MIX)					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	978	90.00	88,020.00	
		1	CORN CONSTRUCTION CO		90.00	88,020.00	+0%
		2	JWJ CONTRACTING CO		90.00	88,020.00	+0%
		3	THE ASHTON CO INC		90.00	88,020.00	+0%
		4	FNF CONSTRUCTION		90.00	88,020.00	+0%
		5	SUNDT CORP.		90.00	88,020.00	+0%
		6	THE TANNER COMPANIES		90.00	88,020.00	+0%
		7	STAKER PAVING & CONSTRUCTION		90.00	88,020.00	+0%
		8	JAMES L FANN CONTRAC		90.00	88,020.00	+0%
		9	JAMES HAMILTON		90.00	88,020.00	+0%
4060028	TON	MINERAL ADMIXTURE (FOR RECYCLED ASPHALTIC CONCRETE)					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	366	90.00	32,940.00	
		1	CORN CONSTRUCTION CO		90.00	32,940.00	+0%
		2	JWJ CONTRACTING CO		90.00	32,940.00	+0%
		3	THE ASHTON CO INC		90.00	32,940.00	+0%
		4	FNF CONSTRUCTION		90.00	32,940.00	+0%
		5	SUNDT CORP.		90.00	32,940.00	+0%
		6	THE TANNER COMPANIES		90.00	32,940.00	+0%
		7	STAKER PAVING & CONSTRUCTION		90.00	32,940.00	+0%
		8	JAMES L FANN CONTRAC		90.00	32,940.00	+0%
		9	JAMES HAMILTON		90.00	32,940.00	+0%

ARIZONA DEPARTMENT OF TRANSPORTATION
CONTRACTS AND SPECIFICATIONS SERVICES

* TABULATION OF BIDS *

PROJ.NO: IR 8-2(91)* CONTRACT NO.: 89104

TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

ITEM NUMBER	UNIT OF MEASURE		ITEM DESCRIPTION	QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
4060053	TON		ASPHALTIC CONCRETE (MODIFIED)(ASPHALT RUBBER)				
		TOTAL BID RANK	DEPARTMENT ESTIMATE	360	27.00	9,720.00	
		1	CORN CONSTRUCTION CO		45.00	16,200.00	+67%
		2	JWJ CONTRACTING CO		25.00	9,000.00	-7%
		3	THE ASHTON CO INC		25.00	9,000.00	-7%
		4	FNF CONSTRUCTION		23.00	8,280.00	-15%
		5	SUNDT CORP.		36.00	12,960.00	+33%
		6	THE TANNER COMPANIES		30.00	10,800.00	+11%
		7	STAKER PAVING & CONSTRUCTION		50.00	18,000.00	+85%
		8	JAMES L FANN CONTRAC		20.00	7,200.00	-26%
		9	JAMES HAMILTON		47.00	16,920.00	+74%
4070001	TON		ASPHALTIC CONCRETE FRICTION COURSE				
		TOTAL BID RANK	DEPARTMENT ESTIMATE	5,994	15.00	89,910.00	
		1	CORN CONSTRUCTION CO		16.00	95,904.00	+7%
		2	JWJ CONTRACTING CO		14.00	83,916.00	-7%
		3	THE ASHTON CO INC		19.00	113,886.00	+27%
		4	FNF CONSTRUCTION		13.00	77,922.00	-13%
		5	SUNDT CORP.		18.00	107,892.00	+20%
		6	THE TANNER COMPANIES		20.00	119,880.00	+33%
		7	STAKER PAVING & CONSTRUCTION		17.00	101,898.00	+13%
		8	JAMES L FANN CONTRAC		15.00	89,910.00	+0%
		9	JAMES HAMILTON		27.00	161,838.00	+80%
4080001	TON		RECYCLED ASPHALTIC CONCRETE				
		TOTAL BID RANK	DEPARTMENT ESTIMATE	35,637	10.00	356,370.00	
		1	CORN CONSTRUCTION CO		11.00	392,007.00	+10%
		2	JWJ CONTRACTING CO		11.00	392,007.00	+10%
		3	THE ASHTON CO INC		12.00	427,644.00	+20%
		4	FNF CONSTRUCTION		11.00	392,007.00	+10%
		5	SUNDT CORP.		11.00	392,007.00	+10%
		6	THE TANNER COMPANIES		12.00	427,644.00	+20%
		7	STAKER PAVING & CONSTRUCTION		10.50	374,188.50	+5%
		8	JAMES L FANN CONTRAC		10.00	356,370.00	+0%
		9	JAMES HAMILTON		16.50	588,010.50	+65%

ARIZONA DEPARTMENT OF TRANSPORTATION
CONTRACTS AND SPECIFICATIONS SERVICES

* TABULATION OF BIDS *

PROJ.NO: IR 8-2(91)*
TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

CONTRACT NO.: 89104

ITEM NUMBER	UNIT OF MEASURE		ITEM DESCRIPTION	QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
4160002	TON		ASPHALTIC CONCRETE (3/4" MIX) (END PRODUCT)	52,414			
		TOTAL BID RANK	DEPARTMENT ESTIMATE		12.00	628,968.00	
		1	CORN CONSTRUCTION CO		11.35	594,898.90	-5%
		2	JWJ CONTRACTING CO		11.70	613,243.80	-2%
		3	THE ASHTON CO INC		12.00	628,968.00	+0%
		4	FNF CONSTRUCTION		11.50	602,761.00	-4%
		5	SUNDT CORP.		11.00	576,554.00	-8%
		6	THE TANNER COMPANIES		11.00	576,554.00	-8%
		7	STAKER PAVING & CONSTRUCTION		10.25	537,243.50	-15%
		8	JAMES L FANN CONTRAC		10.50	550,347.00	-12%
		9	JAMES HAMILTON		14.30	749,520.20	+19%
6010002	CU.YD.		STRUCTURAL CONCRETE (CLASS S) (F'C = 3,000)	163			
		TOTAL BID RANK	DEPARTMENT ESTIMATE		300.00	48,900.00	
		1	CORN CONSTRUCTION CO		270.00	44,010.00	-10%
		2	JWJ CONTRACTING CO		250.00	40,750.00	-17%
		3	THE ASHTON CO INC		300.00	48,900.00	+0%
		4	FNF CONSTRUCTION		350.00	57,050.00	+17%
		5	SUNDT CORP.		300.00	48,900.00	+0%
		6	THE TANNER COMPANIES		300.00	48,900.00	+0%
		7	STAKER PAVING & CONSTRUCTION		340.00	55,420.00	+13%
		8	JAMES L FANN CONTRAC		390.00	63,570.00	+30%
		9	JAMES HAMILTON		370.00	60,310.00	+23%
6040001	LB.		STRUCTURAL STEEL	2,520			
		TOTAL BID RANK	DEPARTMENT ESTIMATE		1.00	2,520.00	
		1	CORN CONSTRUCTION CO		2.00	5,040.00	+100%
		2	JWJ CONTRACTING CO		2.00	5,040.00	+100%
		3	THE ASHTON CO INC		2.00	5,040.00	+100%
		4	FNF CONSTRUCTION		2.50	6,300.00	+150%
		5	SUNDT CORP.		3.00	7,560.00	+200%
		6	THE TANNER COMPANIES		2.00	5,040.00	+100%
		7	STAKER PAVING & CONSTRUCTION		1.70	4,284.00	+70%
		8	JAMES L FANN CONTRAC		5.00	12,600.00	+400%
		9	JAMES HAMILTON		3.00	7,560.00	+200%

ARIZONA DEPARTMENT OF TRANSPORTATION
CONTRACTS AND SPECIFICATIONS SERVICES

* TABULATION OF BIDS *

CONTRACT NO.: 89104

PROJ.NO: IR 8-2(91)*
TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

ITEM NUMBER	UNIT OF MEASURE		ITEM DESCRIPTION	QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
6050002	LB.		REINFORCING STEEL	25,156	.50	12,578.00	+10%
		TOTAL BID RANK	DEPARTMENT ESTIMATE		.55	13,835.80	-20%
		1	CORN CONSTRUCTION CO		.40	10,062.40	-10%
		2	JWJ CONTRACTING CO		.45	11,320.20	+0%
		3	THE ASHTON CO INC		.50	12,578.00	+0%
		4	FNF CONSTRUCTION		.50	12,578.00	+20%
		5	SUNDT CORP.		.60	15,093.60	+0%
		6	THE TANNER COMPANIES		.50	12,578.00	+0%
		7	STAKER PAVING & CONSTRUCTION		.50	12,578.00	+10%
		8	JAMES L FANN CONTRAC		.55	13,835.80	
		9	JAMES HAMILTON				
6050101	EACH		PLACE DOWELS	1,932	14.00	27,048.00	-21%
		TOTAL BID RANK	DEPARTMENT ESTIMATE		11.00	21,252.00	-64%
		1	CORN CONSTRUCTION CO		5.00	9,660.00	-57%
		2	JWJ CONTRACTING CO		6.00	11,592.00	-29%
		3	THE ASHTON CO INC		10.00	19,320.00	-36%
		4	FNF CONSTRUCTION		9.00	17,388.00	-29%
		5	SUNDT CORP.		10.00	19,320.00	-29%
		6	THE TANNER COMPANIES		10.00	19,320.00	-14%
		7	STAKER PAVING & CONSTRUCTION		12.00	23,184.00	-21%
		8	JAMES L FANN CONTRAC		11.00	21,252.00	
		9	JAMES HAMILTON				
7010001	L.SUM		MAINTENANCE AND PROTECTION OF TRAFFIC	1	212,000.00	212,000.00	+0%
		TOTAL BID RANK	DEPARTMENT ESTIMATE		212,000.00	212,000.00	+0%
		1	CORN CONSTRUCTION CO		212,000.00	212,000.00	+0%
		2	JWJ CONTRACTING CO		212,000.00	212,000.00	+0%
		3	THE ASHTON CO INC		212,000.00	212,000.00	+0%
		4	FNF CONSTRUCTION		212,000.00	212,000.00	+0%
		5	SUNDT CORP.		212,000.00	212,000.00	+0%
		6	THE TANNER COMPANIES		212,000.00	212,000.00	+0%
		7	STAKER PAVING & CONSTRUCTION		212,000.00	212,000.00	+0%
		8	JAMES L FANN CONTRAC		212,000.00	212,000.00	
		9	JAMES HAMILTON				

ARIZONA DEPARTMENT OF TRANSPORTATION
CONTRACTS AND SPECIFICATIONS SERVICES

* TABULATION OF BIDS *

CONTRACT NO.: 89104

PROJ.NO: IR 8-2(91)*
TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION	QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
7010006	L.SUM	FURNISH AND INSTALL TEMPORARY TRAFFIC CONTROL DEVICES	1			
	TOTAL BID RANK	DEPARTMENT ESTIMATE		18,000.00	18,000.00	
	1	CORN CONSTRUCTION CO		30,000.00	30,000.00	+67%
	2	JWJ CONTRACTING CO		25,000.00	25,000.00	+39%
	3	THE ASHTON CO INC		10,000.00	10,000.00	-44%
	4	FNF CONSTRUCTION		35,000.00	35,000.00	+94%
	5	SUNDT CORP.		80,000.00	80,000.00	+344%
	6	THE TANNER COMPANIES		35,000.00	35,000.00	+94%
	7	STAKER PAVING & CONSTRUCTION		100,000.00	100,000.00	+456%
	8	JAMES L FANN CONTRAC		42,000.00	42,000.00	+133%
	9	JAMES HAMILTON		75,000.00	75,000.00	+317%
7010010	L.FT.	TEMPORARY CONCRETE BARRIER (NEW INSTALLATION)	6,600			
	TOTAL BID RANK	DEPARTMENT ESTIMATE		13.00	85,800.00	
	1	CORN CONSTRUCTION CO		6.00	39,600.00	-54%
	2	JWJ CONTRACTING CO		5.00	33,000.00	-62%
	3	THE ASHTON CO INC		6.00	39,600.00	-54%
	4	FNF CONSTRUCTION		6.00	39,600.00	-54%
	5	SUNDT CORP.		6.00	39,600.00	-54%
	6	THE TANNER COMPANIES		5.00	33,000.00	-62%
	7	STAKER PAVING & CONSTRUCTION		7.75	51,150.00	-40%
	8	JAMES L FANN CONTRAC		9.00	59,400.00	-31%
	9	JAMES HAMILTON		8.50	56,100.00	-35%
7040003	L.FT.	PAVEMENT MARKING (WHITE HOT SPRAYED THERMOPLASTIC)(0.060")	107,000			
	TOTAL BID RANK	DEPARTMENT ESTIMATE		.20	21,400.00	
	1	CORN CONSTRUCTION CO		.16	17,120.00	-20%
	2	JWJ CONTRACTING CO		.16	17,120.00	-20%
	3	THE ASHTON CO INC		.15	16,050.00	-25%
	4	FNF CONSTRUCTION		.18	19,260.00	-10%
	5	SUNDT CORP.		.17	18,190.00	-15%
	6	THE TANNER COMPANIES		.20	21,400.00	+0%
	7	STAKER PAVING & CONSTRUCTION		.20	21,400.00	+0%
	8	JAMES L FANN CONTRAC		.19	20,330.00	-5%
	9	JAMES HAMILTON		.20	21,400.00	+0%

ARIZONA DEPARTMENT OF TRANSPORTATION
CONTRACTS AND SPECIFICATIONS SERVICES

*** TABULATION OF BIDS ***

CONTRACT NO.: 89104

PROJ.NO: IR 8-2(91)*
TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

ITEM NUMBER	UNIT OF MEASURE	TOTAL BID RANK	ITEM DESCRIPTION	QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
7040004	L.FT.		PAVEMENT MARKING (YELLOW HOT SPRAYED THERMOPLASTIC)(0.060")	84,000	.20	16,800.00	
			DEPARTMENT ESTIMATE		.16	13,440.00	-20%
		1	CORN CONSTRUCTION CO		.16	13,440.00	-20%
		2	JWJ CONTRACTING CO		.15	12,600.00	-25%
		3	THE ASHTON CO INC		.18	15,120.00	-10%
		4	FNF CONSTRUCTION		.17	14,280.00	-15%
		5	SUNDT CORP.		.20	16,800.00	+0%
		6	THE TANNER COMPANIES		.20	16,800.00	+0%
		7	STAKER PAVING & CONSTRUCTION		.19	15,960.00	-5%
		8	JAMES L FANN CONTRAC		.20	16,800.00	+0%
		9	JAMES HAMILTON				
7050022	L.FT.		PAVEMENT MARKING, PREFORMED, TYPE I, WHITE STRIPE	800	1.50	1,200.00	
			DEPARTMENT ESTIMATE		1.50	1,200.00	+0%
		1	CORN CONSTRUCTION CO		1.25	1,000.00	-17%
		2	JWJ CONTRACTING CO		1.00	800.00	-33%
		3	THE ASHTON CO INC		1.50	1,200.00	+0%
		4	FNF CONSTRUCTION		1.50	1,200.00	+0%
		5	SUNDT CORP.		2.00	1,600.00	+33%
		6	THE TANNER COMPANIES		1.30	1,040.00	-13%
		7	STAKER PAVING & CONSTRUCTION		1.50	1,200.00	+0%
		8	JAMES L FANN CONTRAC		1.60	1,280.00	+7%
		9	JAMES HAMILTON				
7050023	EACH		PAVEMENT MARKING, PREFORMED, TYPE I, SINGLE ARROW	4	125.00	500.00	
			DEPARTMENT ESTIMATE		100.00	400.00	-20%
		1	CORN CONSTRUCTION CO		100.00	400.00	-20%
		2	JWJ CONTRACTING CO		75.00	300.00	-40%
		3	THE ASHTON CO INC		100.00	400.00	-20%
		4	FNF CONSTRUCTION		100.00	400.00	-20%
		5	SUNDT CORP.		150.00	600.00	+20%
		6	THE TANNER COMPANIES		100.00	400.00	-20%
		7	STAKER PAVING & CONSTRUCTION		120.00	480.00	-4%
		8	JAMES L FANN CONTRAC		100.00	400.00	-20%
		9	JAMES HAMILTON				

ARIZONA DEPARTMENT OF TRANSPORTATION
CONTRACTS AND SPECIFICATIONS SERVICES

* TABULATION OF BIDS *

CONTRACT NO.: 89104

PROJ.NO: IR 8-2(91)*
TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

ITEM NUMBER	UNIT OF MEASURE		ITEM DESCRIPTION	QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
9050001	L.FT.	GUARD RAIL,	W-BEAM, SINGLE FACE	17,676			
		TOTAL BID RANK	DEPARTMENT ESTIMATE		10.50	185,598.00	
		1	CORN CONSTRUCTION CO		8.75	154,665.00	-17%
		2	JWJ CONTRACTING CO		8.10	143,175.60	-23%
		3	THE ASHTON CO INC		10.00	176,760.00	-5%
		4	FNF CONSTRUCTION		8.50	150,246.00	-19%
		5	SUNDT CORP.		11.00	194,436.00	+5%
		6	THE TANNER COMPANIES		9.00	159,084.00	-14%
		7	STAKER PAVING & CONSTRUCTION		8.20	144,943.20	-22%
		8	JAMES L FANN CONTRAC		10.50	185,598.00	+0%
		9	JAMES HAMILTON		10.20	180,295.20	-3%
9050031	EACH	GUARD RAIL,	BREAKAWAY CABLE TERMINAL	56			
		TOTAL BID RANK	DEPARTMENT ESTIMATE		850.00	47,600.00	
		1	CORN CONSTRUCTION CO		685.00	38,360.00	-19%
		2	JWJ CONTRACTING CO		650.00	36,400.00	-24%
		3	THE ASHTON CO INC		700.00	39,200.00	-18%
		4	FNF CONSTRUCTION		650.00	36,400.00	-24%
		5	SUNDT CORP.		750.00	42,000.00	-12%
		6	THE TANNER COMPANIES		800.00	44,800.00	-6%
		7	STAKER PAVING & CONSTRUCTION		650.00	36,400.00	-24%
		8	JAMES L FANN CONTRAC		920.00	51,520.00	+8%
		9	JAMES HAMILTON		770.00	43,120.00	-9%
9050036	EACH	GUARD RAIL,	ANCHOR ASSEMBLY	45			
		TOTAL BID RANK	DEPARTMENT ESTIMATE		600.00	27,000.00	
		1	CORN CONSTRUCTION CO		450.00	20,250.00	-25%
		2	JWJ CONTRACTING CO		450.00	20,250.00	-25%
		3	THE ASHTON CO INC		600.00	27,000.00	+0%
		4	FNF CONSTRUCTION		425.00	19,125.00	-29%
		5	SUNDT CORP.		600.00	27,000.00	+0%
		6	THE TANNER COMPANIES		500.00	22,500.00	-17%
		7	STAKER PAVING & CONSTRUCTION		430.00	19,350.00	-28%
		8	JAMES L FANN CONTRAC		580.00	26,100.00	-3%
		9	JAMES HAMILTON		550.00	24,750.00	-8%

ARIZONA DEPARTMENT OF TRANSPORTATION
CONTRACTS AND SPECIFICATIONS SERVICES

* TABULATION OF BIDS *

PROJ.NO: IR 8-2(91)* CONTRACT NO.: 89104
TRACS ||||| || | ROUTE |||| MILEPOST ||| COUNTY ||

ITEM NUMBER	UNIT OF MEASURE		ITEM DESCRIPTION	QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
9050106	EACH		RECONSTRUCT GUARD RAIL BREAKAWAY CABLE TERMINAL				
		TOTAL BID RANK	DEPARTMENT ESTIMATE	2	500.00	1,000.00	
		1	CORN CONSTRUCTION CO		450.00	900.00	-10%
		2	JWJ CONTRACTING CO		400.00	800.00	-20%
		3	THE ASHTON CO INC		350.00	700.00	-30%
		4	FNF CONSTRUCTION		400.00	800.00	-20%
		5	SUNDT CORP.		350.00	700.00	-30%
		6	THE TANNER COMPANIES		500.00	1,000.00	+0%
		7	STAKER PAVING & CONSTRUCTION		400.00	800.00	-20%
		8	JAMES L FANN CONTRAC		350.00	700.00	-30%
		9	JAMES HAMILTON		330.00	660.00	-34%
9050110	L.FT.		RECONSTRUCT GUARD RAIL				
		TOTAL BID RANK	DEPARTMENT ESTIMATE	14,113	4.00	56,452.00	
		1	CORN CONSTRUCTION CO		3.00	42,339.00	-25%
		2	JWJ CONTRACTING CO		3.00	42,339.00	-25%
		3	THE ASHTON CO INC		2.50	35,282.50	-37%
		4	FNF CONSTRUCTION		3.00	42,339.00	-25%
		5	SUNDT CORP.		4.00	56,452.00	+0%
		6	THE TANNER COMPANIES		3.50	49,395.50	-12%
		7	STAKER PAVING & CONSTRUCTION		2.90	40,927.70	-27%
		8	JAMES L FANN CONTRAC		4.00	56,452.00	+0%
		9	JAMES HAMILTON		4.00	56,452.00	+0%
9050201	L.FT.		GUARD RAIL ANCHORAGE, BURIED				
		TOTAL BID RANK	DEPARTMENT ESTIMATE	50	35.00	1,750.00	
		1	CORN CONSTRUCTION CO		50.00	2,500.00	+43%
		2	JWJ CONTRACTING CO		50.00	2,500.00	+43%
		3	THE ASHTON CO INC		40.00	2,000.00	+14%
		4	FNF CONSTRUCTION		45.00	2,250.00	+29%
		5	SUNDT CORP.		22.00	1,100.00	-37%
		6	THE TANNER COMPANIES		50.00	2,500.00	+43%
		7	STAKER PAVING & CONSTRUCTION		50.00	2,500.00	+43%
		8	JAMES L FANN CONTRAC		25.00	1,250.00	-29%
		9	JAMES HAMILTON		22.00	1,100.00	-37%

ARIZONA DEPARTMENT OF TRANSPORTATION
CONTRACTS AND SPECIFICATIONS SERVICES

* TABULATION OF BIDS *

CONTRACT NO.: 89104

PROJ.NO: IR 8-2(91)*
TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION	QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
9050206	EACH	GUARD RAIL ANCHORAGE, BOLTED	166	250.00	41,500.00	
	TOTAL BID RANK	DEPARTMENT ESTIMATE		155.00	25,730.00	-38%
	1	CORN CONSTRUCTION CO		150.00	24,900.00	-40%
	2	JWJ CONTRACTING CO		125.00	20,750.00	-50%
	3	THE ASHTON CO INC		150.00	24,900.00	-40%
	4	FNF CONSTRUCTION		250.00	41,500.00	+0%
	5	SUNDT CORP.		200.00	33,200.00	-20%
	6	THE TANNER COMPANIES		150.00	24,900.00	-40%
	7	STAKER PAVING & CONSTRUCTION		260.00	43,160.00	+4%
	8	JAMES L FANN CONTRAC		250.00	41,500.00	+0%
	9	JAMES HAMILTON				
9050301	EACH	GUARD RAIL RUB RAIL	13	350.00	4,550.00	
	TOTAL BID RANK	DEPARTMENT ESTIMATE		335.00	4,355.00	-4%
	1	CORN CONSTRUCTION CO		350.00	4,550.00	+0%
	2	JWJ CONTRACTING CO		375.00	4,875.00	+7%
	3	THE ASHTON CO INC		320.00	4,160.00	-9%
	4	FNF CONSTRUCTION		450.00	5,850.00	+29%
	5	SUNDT CORP.		350.00	4,550.00	+0%
	6	THE TANNER COMPANIES		315.00	4,095.00	-10%
	7	STAKER PAVING & CONSTRUCTION		460.00	5,980.00	+31%
	8	JAMES L FANN CONTRAC		440.00	5,720.00	+26%
	9	JAMES HAMILTON				
9050310	EACH	RECONSTRUCT RUB RAIL	2	250.00	500.00	
	TOTAL BID RANK	DEPARTMENT ESTIMATE		200.00	400.00	-20%
	1	CORN CONSTRUCTION CO		150.00	300.00	-40%
	2	JWJ CONTRACTING CO		150.00	300.00	-40%
	3	THE ASHTON CO INC		150.00	300.00	-40%
	4	FNF CONSTRUCTION		180.00	360.00	-28%
	5	SUNDT CORP.		200.00	400.00	-20%
	6	THE TANNER COMPANIES		150.00	300.00	-40%
	7	STAKER PAVING & CONSTRUCTION		175.00	350.00	-30%
	8	JAMES L FANN CONTRAC		170.00	340.00	-32%
	9	JAMES HAMILTON				

ARIZONA DEPARTMENT OF TRANSPORTATION
CONTRACTS AND SPECIFICATIONS SERVICES
* TABULATION OF BIDS *

PROJ.NO: IR 8-2(91)* CONTRACT NO.: 89104
TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION		QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
9100007	EACH	CONCRETE HALF BARRIER TRANSITION (20-FT)					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	1	1,300.00	1,300.00	
		1	CORN CONSTRUCTION CO		1,500.00	1,500.00	+15%
		2	JWJ CONTRACTING CO		250.00	250.00	-81%
		3	THE ASHTON CO INC		1,500.00	1,500.00	+15%
		4	FNF CONSTRUCTION		3,300.00	3,300.00	+154%
		5	SUNDT CORP.		4,000.00	4,000.00	+208%
		6	THE TANNER COMPANIES		2,500.00	2,500.00	+92%
		7	STAKER PAVING & CONSTRUCTION		3,000.00	3,000.00	+131%
		8	JAMES L FANN CONTRAC		3,500.00	3,500.00	+169%
		9	JAMES HAMILTON		3,300.00	3,300.00	+154%
9100008	L.FT.	CONCRETE BARRIER ( )					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	2,600	35.00	91,000.00	
		1	CORN CONSTRUCTION CO		22.50	58,500.00	-36%
		2	JWJ CONTRACTING CO		15.00	39,000.00	-57%
		3	THE ASHTON CO INC		26.00	67,600.00	-26%
		4	FNF CONSTRUCTION		35.00	91,000.00	+0%
		5	SUNDT CORP.		26.00	67,600.00	-26%
		6	THE TANNER COMPANIES		28.00	72,800.00	-20%
		7	STAKER PAVING & CONSTRUCTION		33.00	85,800.00	-6%
		8	JAMES L FANN CONTRAC		38.00	98,800.00	+9%
		9	JAMES HAMILTON		36.00	93,600.00	+3%
9160001	L.FT.	EMBANKMENT CURB					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	6,240	2.50	15,600.00	
		1	CORN CONSTRUCTION CO		2.50	15,600.00	+0%
		2	JWJ CONTRACTING CO		2.00	12,480.00	-20%
		3	THE ASHTON CO INC		2.25	14,040.00	-10%
		4	FNF CONSTRUCTION		2.50	15,600.00	+0%
		5	SUNDT CORP.		2.00	12,480.00	-20%
		6	THE TANNER COMPANIES		2.00	12,480.00	-20%
		7	STAKER PAVING & CONSTRUCTION		2.30	14,352.00	-8%
		8	JAMES L FANN CONTRAC		3.00	18,720.00	+20%
		9	JAMES HAMILTON		2.50	15,600.00	+0%

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* TABULATION OF BIDS *
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PROJ.NO: IR 8-2(91)* * * CONTRACT NO.: 89104
TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION		QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
9170023	EACH	INLET (C-4.10) (SINGLE) ( )					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	12	600.00	7,200.00	
		1	CORN CONSTRUCTION CO		1,200.00	14,400.00	+100%
		2	JWJ CONTRACTING CO		750.00	9,000.00	+25%
		3	THE ASHTON CO INC		400.00	4,800.00	-33%
		4	FNF CONSTRUCTION		1,050.00	12,600.00	+75%
		5	SUNDT CORP.		500.00	6,000.00	-17%
		6	THE TANNER COMPANIES		600.00	7,200.00	+0%
		7	STAKER PAVING & CONSTRUCTION		870.00	10,440.00	+45%
		8	JAMES L FANN CONTRAC		1,000.00	12,000.00	+67%
		9	JAMES HAMILTON		1,000.00	12,000.00	+67%
9170033	EACH	INLET (C-4.20) (SINGLE) ( )					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	12	600.00	7,200.00	
		1	CORN CONSTRUCTION CO		1,500.00	18,000.00	+150%
		2	JWJ CONTRACTING CO		750.00	9,000.00	+25%
		3	THE ASHTON CO INC		400.00	4,800.00	-33%
		4	FNF CONSTRUCTION		1,500.00	18,000.00	+150%
		5	SUNDT CORP.		600.00	7,200.00	+0%
		6	THE TANNER COMPANIES		800.00	9,600.00	+33%
		7	STAKER PAVING & CONSTRUCTION		1,200.00	14,400.00	+100%
		8	JAMES L FANN CONTRAC		1,350.00	16,200.00	+125%
		9	JAMES HAMILTON		1,400.00	16,800.00	+133%
9230001	HOUR	PROVIDE TRAINEES WITH ON-THE-JOB TRAINING					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	1,100	.80	880.00	
		1	CORN CONSTRUCTION CO		.80	880.00	+0%
		2	JWJ CONTRACTING CO		.80	880.00	+0%
		3	THE ASHTON CO INC		.80	880.00	+0%
		4	FNF CONSTRUCTION		.80	880.00	+0%
		5	SUNDT CORP.		.80	880.00	+0%
		6	THE TANNER COMPANIES		.80	880.00	+0%
		7	STAKER PAVING & CONSTRUCTION		.80	880.00	+0%
		8	JAMES L FANN CONTRAC		.80	880.00	+0%
		9	JAMES HAMILTON		.80	880.00	+0%

ARIZONA DEPARTMENT OF TRANSPORTATION
CONTRACTS AND SPECIFICATIONS SERVICES

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* TABULATION OF BIDS *
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PROJ.NO: IR 8-2(91)*
TRACS ##### ## # ROUTE #### MILEPOST ### COUNTY ##

CONTRACT NO.: 89104

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION		QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
9250001	L.SUM	CONSTRUCTION SURVEYING AND LAYOUT		1			
		TOTAL BID RANK	DEPARTMENT ESTIMATE		40,000.00	40,000.00	
		1	CORN CONSTRUCTION CO		15,000.00	15,000.00	-62%
		2	JWJ CONTRACTING CO		25,000.00	25,000.00	-37%
		3	THE ASHTON CO INC		15,000.00	15,000.00	-62%
		4	FNF CONSTRUCTION		20,000.00	20,000.00	-50%
		5	SUNDT CORP.		35,000.00	35,000.00	-12%
		6	THE TANNER COMPANIES		25,000.00	25,000.00	-37%
		7	STAKER PAVING & CONSTRUCTION		16,000.00	16,000.00	-60%
		8	JAMES L FANN CONTRAC		15,000.00	15,000.00	-62%
		9	JAMES HAMILTON		25,000.00	25,000.00	-37%
9250102	HOUR	TWO-PERSON SURVEY PARTY		24			
		TOTAL BID RANK	DEPARTMENT ESTIMATE		65.00	1,560.00	
		1	CORN CONSTRUCTION CO		65.00	1,560.00	+0%
		2	JWJ CONTRACTING CO		65.00	1,560.00	+0%
		3	THE ASHTON CO INC		65.00	1,560.00	+0%
		4	FNF CONSTRUCTION		65.00	1,560.00	+0%
		5	SUNDT CORP.		65.00	1,560.00	+0%
		6	THE TANNER COMPANIES		65.00	1,560.00	+0%
		7	STAKER PAVING & CONSTRUCTION		65.00	1,560.00	+0%
		8	JAMES L FANN CONTRAC		65.00	1,560.00	+0%
		9	JAMES HAMILTON		65.00	1,560.00	+0%
9250103	HOUR	THREE-PERSON SURVEY PARTY		24			
		TOTAL BID RANK	DEPARTMENT ESTIMATE		75.00	1,800.00	
		1	CORN CONSTRUCTION CO		75.00	1,800.00	+0%
		2	JWJ CONTRACTING CO		75.00	1,800.00	+0%
		3	THE ASHTON CO INC		75.00	1,800.00	+0%
		4	FNF CONSTRUCTION		75.00	1,800.00	+0%
		5	SUNDT CORP.		75.00	1,800.00	+0%
		6	THE TANNER COMPANIES		75.00	1,800.00	+0%
		7	STAKER PAVING & CONSTRUCTION		75.00	1,800.00	+0%
		8	JAMES L FANN CONTRAC		75.00	1,800.00	+0%
		9	JAMES HAMILTON		75.00	1,800.00	+0%

ARIZONA DEPARTMENT OF TRANSPORTATION
CONTRACTS AND SPECIFICATIONS SERVICES

* TABULATION OF BIDS *

PROJ.NO: IR 8-2(91)*
TRACS ||||| || | ROUTE |||| MILEPOST ||| COUNTY ||

CONTRACT NO.: 89104

ITEM NUMBER	UNIT OF MEASURE	ITEM DESCRIPTION		QUANTITY	UNIT PRICE	EXTENDED AMOUNT	COMPARED TO DEPARTMENT ESTIMATE
9250104	HOUR	FOUR-PERSON SURVEY PARTY					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	24	85.00	2,040.00	
		1	CORN CONSTRUCTION CO		85.00	2,040.00	+0%
		2	JWJ CONTRACTING CO		85.00	2,040.00	+0%
		3	THE ASHTON CO INC		85.00	2,040.00	+0%
		4	FNF CONSTRUCTION		85.00	2,040.00	+0%
		5	SUNDT CORP.		85.00	2,040.00	+0%
		6	THE TANNER COMPANIES		85.00	2,040.00	+0%
		7	STAKER PAVING & CONSTRUCTION		85.00	2,040.00	+0%
		8	JAMES L FANN CONTRAC		85.00	2,040.00	+0%
		9	JAMES HAMILTON		85.00	2,040.00	+0%
9280001	L.FT.	FORMED RUMBLE STRIP					
		TOTAL BID RANK	DEPARTMENT ESTIMATE	139,200	.10	13,920.00	
		1	CORN CONSTRUCTION CO		.08	11,136.00	-20%
		2	JWJ CONTRACTING CO		.15	20,880.00	+50%
		3	THE ASHTON CO INC		.10	13,920.00	+0%
		4	FNF CONSTRUCTION		.10	13,920.00	+0%
		5	SUNDT CORP.		.10	13,920.00	+0%
		6	THE TANNER COMPANIES		.15	20,880.00	+50%
		7	STAKER PAVING & CONSTRUCTION		.10	13,920.00	+0%
		8	JAMES L FANN CONTRAC		.10	13,920.00	+0%
		9	JAMES HAMILTON		.10	13,920.00	+0%

APPENDIX D

STRATEGIC HIGHWAY RESEARCH PROGRAM (SHRP)

SPECIFIC PAVEMENT STUDIES; PRELIMINARY CONSTRUCTION GUIDELINES FOR EXPERIMENT SPS-5: REHABILITATION OF ASPHALT CONCRETE PAVEMENTS

Operational Memorandum No
SHRP-LTPP-OM-0##

National Research Council

STRATEGIC HIGHWAY RESEARCH PROGRAM

SPECIFIC PAVEMENT STUDIES
PRELIMINARY CONSTRUCTION GUIDELINES
FOR EXPERIMENT SPS-5
REHABILITATION OF ASPHALT CONCRETE PAVEMENTS

STRATEGIC HIGHWAY RESEARCH PROGRAM
818 Connecticut Avenue NW
Washington, DC 20006

MARCH 1990

WORKING DOCUMENT

SPECIFIC PAVEMENT STUDIES: PRELIMINARY CONSTRUCTION GUIDELINES FOR EXPERIMENT SPS-5, REHABILITATION OF ASPHALT CONCRETE PAVEMENTS

STRATEGIC HIGHWAY RESEARCH PROGRAM
818 Connecticut Avenue NW
Washington, DC 20006

APRIL 1990

PRELIMINARY CONSTRUCTION GUIDELINES FOR EXPERIMENT SPS-5
REHABILITATION OF ASPHALT CONCRETE PAVEMENTS

INTRODUCTION

The SHRP Specific Pavement Studies experiment 5, Rehabilitation of Asphaltic Concrete Pavements, is designed as a coordinated national experiment. In contrast to the General Pavement Studies which are composed of existing pavements, the SPS studies start from construction of multiple test sections on each project. This offers the opportunity to document the complete performance history of the overlay starting from construction. Control of the uniformity of construction practices across projects is of prime importance in the SPS studies. Significant construction variations can severely limit the value offered by a national study of this type in determining effects such as climate.

The preliminary guidelines in this document are intended to serve as a starting point, or strawman, for discussions with participating agencies on development of the final construction guidelines for SPS-5. It is SHRP's intent to include the input of participating agencies. Successful implementation of this experiment is directly dependent upon participating agencies. In the process of arriving at a consensus on a nationwide scope, compromises must be made. This experiment will require construction of test sections with some attributes which differ from local practice or applied in non-typical situations. These are among the challenges inherent in the participatory performance research of the SHRP LTPP program.

The details of the experiment design and general construction considerations are contained in the document, "Specific Pavement Studies, Experimental Design and Research Plan for Experiment SPS-5, Rehabilitation of Asphalt Concrete Pavements," Strategic Highway Research Program, April, 1989.

OBJECTIVE

The objective of this document is to provide guidelines for preparing and constructing SPS-5 test sections to maximize uniformity of these procedures across all projects. More specifically, the objectives are:

- To review the major construction features of the SPS-5 experiment test sections.
- To describe the details of the two major experimental levels of preparation of the test sections prior to construction.
- To provide specifications for material to be used (aggregates, asphalts) and the mix design (virgin, recycled).
- To describe the construction operations (mix plant, hauling, placing, compaction) and as-built requirements (surface roughness).

In addition, special considerations related to friction courses, stripped surfaces, geometric corrections and treatments not to be performed on the test sections are addressed in this document.

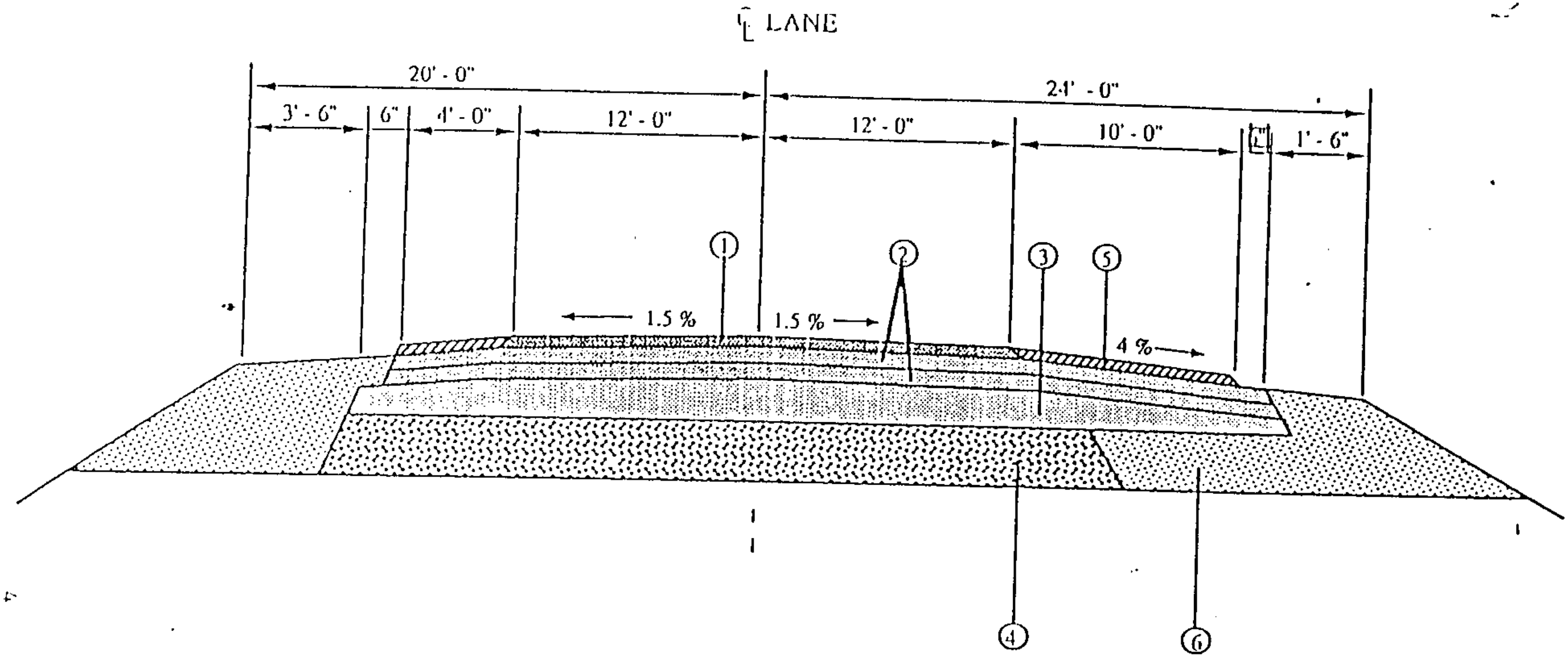
TYPICAL SECTIONS

The combinations of experimental factors for the eight SPS 5 test sections are shown in Table 1. The control section, which does not receive an overlay, is shown as section 1 in this table. The test section numbers shown in this table are used to reference the test sections in the remainder of this document.

The typical cross sections presented in this document were developed for the hypothetical existing pavement structure shown in Figure 1. The depicted pavement structure is two lanes of a four lane divided highway structure with a crowned cross section. The pavement structure consists of an untreated aggregate base, a plant mix bituminous base, and a hot mixed asphaltic concrete (HMAC) pavement with a 1.5" surface course. Since no rehabilitation treatments will be applied to the control section at the start of the study, this figure also represents the cross section of the control section (section 1).

Table 1. SPS-5 Test section numbering scheme.

SPS-5 SECTION NO.	PREPARATION	OVERLAY MATERIAL	OVERLAY THICKNESS INCHES
1	Routine Maintenance	No Overlay	—
2	Minimum	Recycled HMAC	2
3	Minimum	Recycled HMAC	5
4	Minimum	Virgin HMAC	5
5	Minimum	Virgin HMAC	2
6	Intensive	Virgin HMAC	2
7	Intensive	Virgin HMAC	5
8	Intensive	Recycled HMAC	5
9	Intensive	Recycled HMAC	2



LEGEND

① 1 1/2" Hot Bituminous Pavement Surface Course

② 4" Hot Bituminous Pavement Surface Binder Course (2 @2")

③ 4" Plant Mix Bituminous Base

④ 6" Aggregate Base

⑤ Double Bituminous Surface Treatment

⑥ Select variable thickness granular fill

Figure 1. SPS-5 section 1, control section - routine maintenance - no overlay.

The typical sections for the test sections with minimal surface preparation treatments, are shown in Figures 2-5. These are the sections which are not milled. The specific layer combinations and thicknesses shown in these figures are illustrative of the expected test section cross sections. Agencies can alter some of the cross section details, within the limits defined in this document, to meet local design and construction practice.

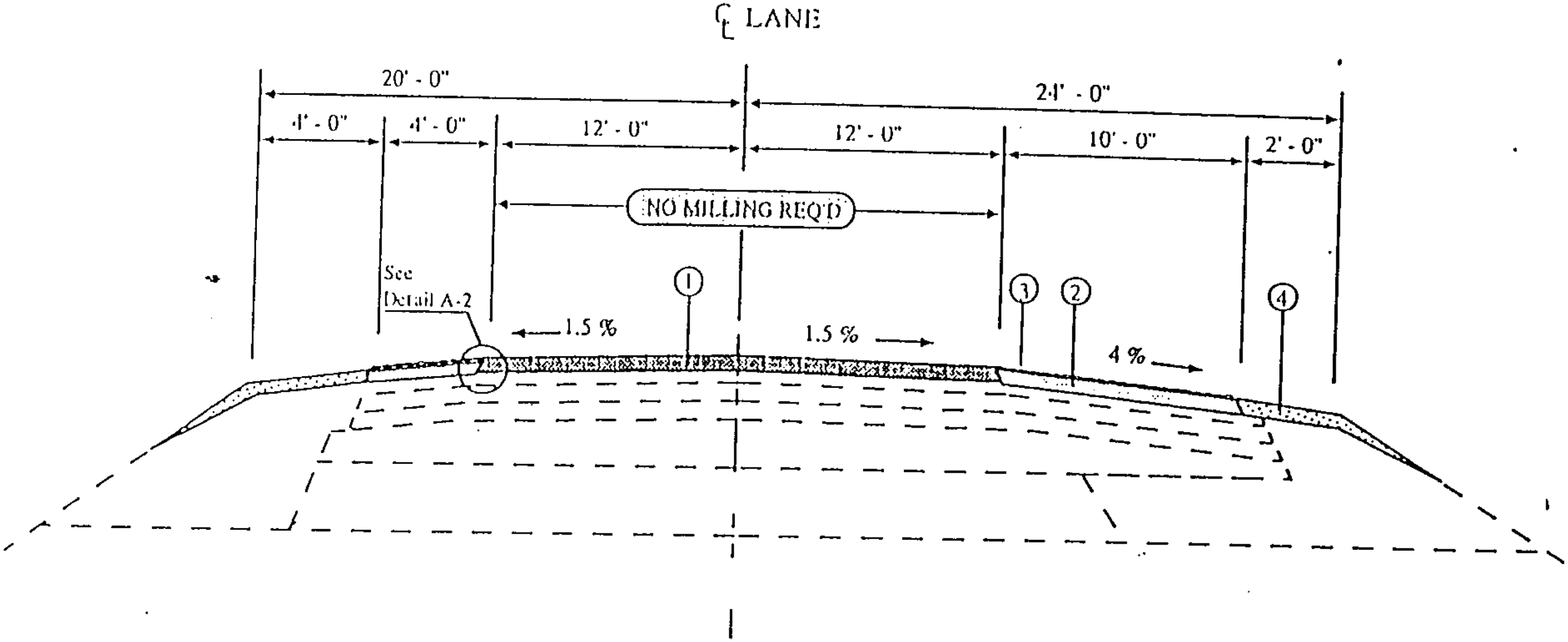
Section 2, shown in Figure 2, consists of a 2" recycled HMAC overlay. Due to the thickness of this layer, the overlay is shown as composed entirely of a surface course mixture. A recycled HMAC binder course mixture topped with a surface treatment is shown for level up of the shoulders.

Figure 3 illustrates section 3, the 5" recycled HMAC overlay test section. The AC pavement structure consists of a 2" recycled AC surface course with two 1½" thick lifts of recycled AC binder course. Three 1½" lifts of recycled AC binder course topped with a surface treatment are shown for the shoulders.

The only differences between sections 4 and 5, shown in Figures 4 and 5, and sections 3 and 2, respectively, is the use of all "virgin" HMAC materials in the overlay pavement structure.

Details of the shoulder joint on sections 2-5 are shown in Figure 6.

Sections 6 through 9, shown in Figures 7-10, are intensive surface preparation sections which include milling. Milling of 2" of the pavement surface is shown for these sections. On this hypothetical pavement section, the existing surface course and 1/2" of the binder course are removed. The milled area is replaced with a 2" lift of either recycled or virgin AC binder course material, depending on the test section. The details of the overlay pavement structure placed on top of this lift are the same as those of the corresponding test sections without milling. Figure 11 presents the details of the shoulder joints for these sections.

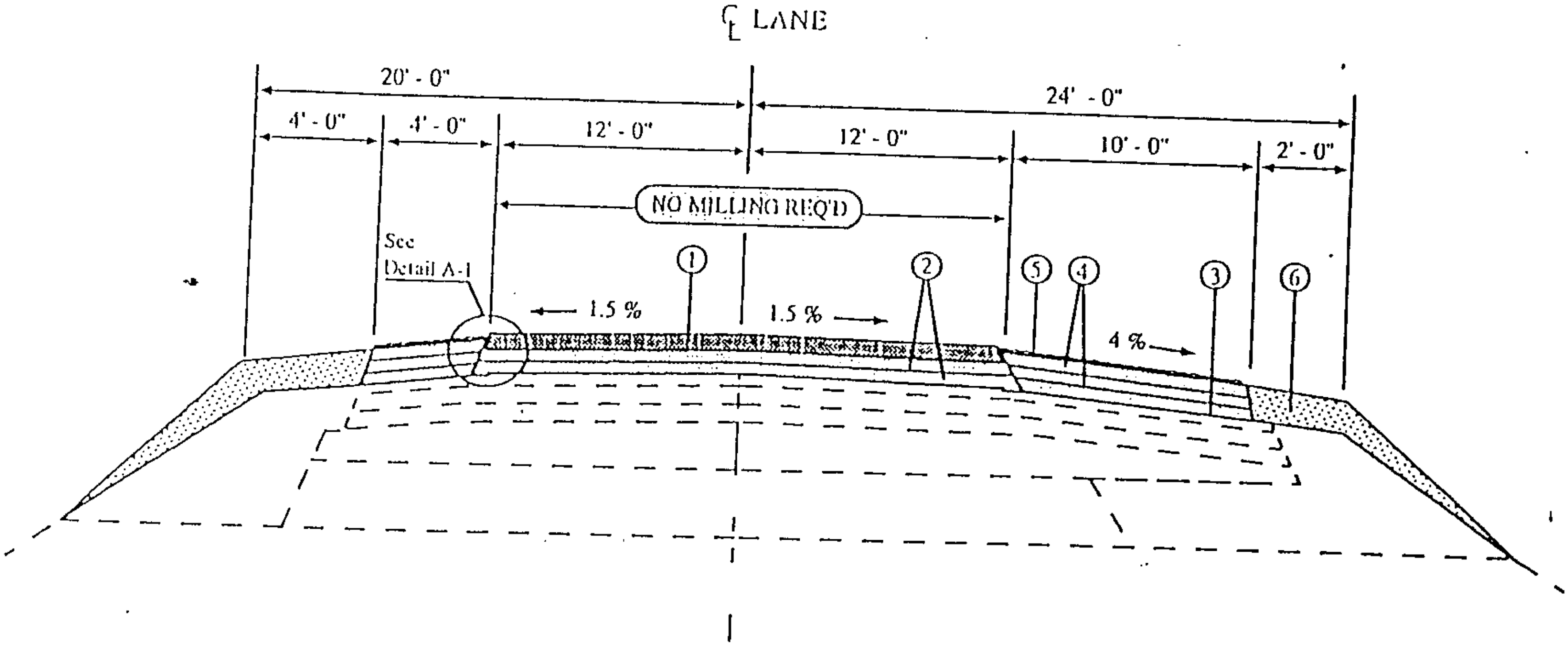


LEGEND

1. 2" Hot Recycled Bituminous Pavement Surface Course
2. 1 1/2" and variable depth Hot Recycled Bituminous Pavement Binder Course
3. Single Bituminous Surface Treatment
4. 1 1/2" and variable depth granular material

— — — Existing pavement structure

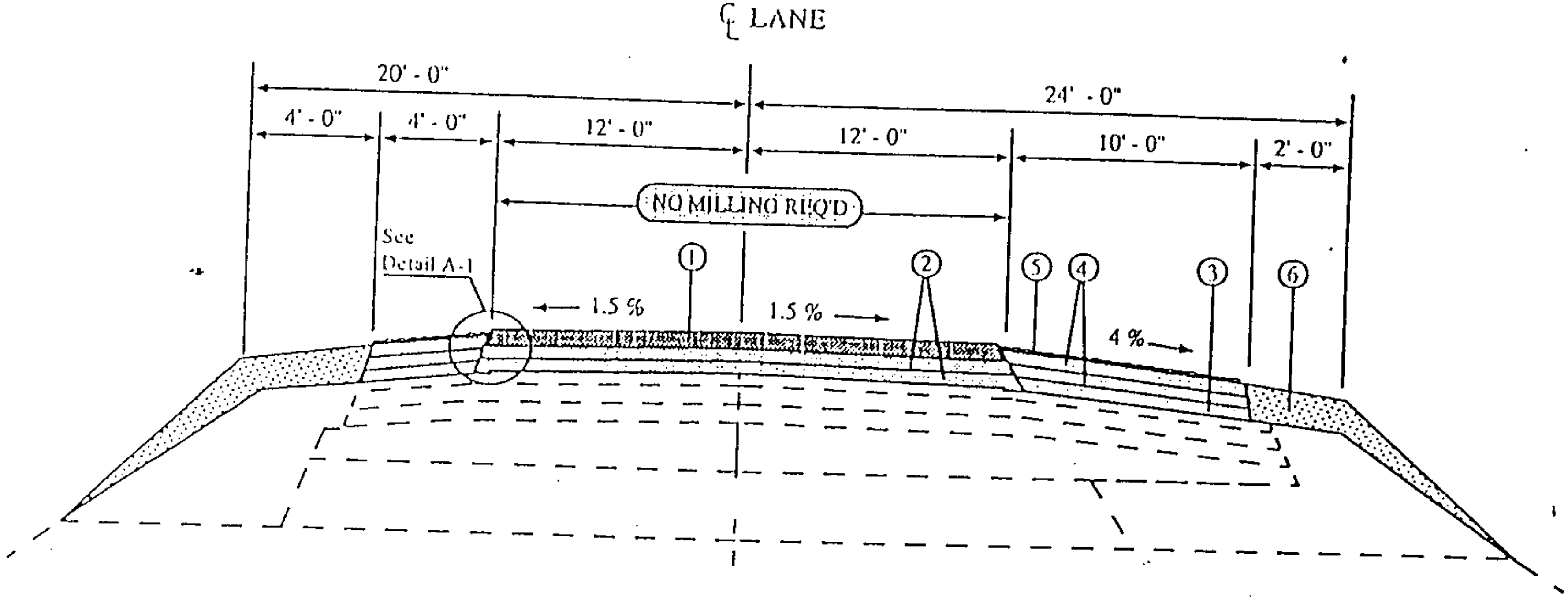
Figure 2. SPS-5 section 2, 2 inch recycled AC overlay, no milling.



LEGEND

1	2"	Hot Recycled Bituminous Pavement Surface Course
2	3"	and variable depth Hot Recycled Bituminous Pavement Binder Course (2 @ 1 1/2")
3	1 1/2"	and variable depth Hot Recycled Bituminous Pavement Binder Course
4	3"	Hot Recycled Bituminous Pavement Binder Course (2 @ 1 1/2")
5		Single Bituminous Surface Treatment
6	4 1/2"	and variable depth granular material
— — —		Existing pavement structure

Figure 3. SPS-5 section 3, 5 inch recycled AC overlay, no milling.



LEGEND

① 2" Hot Bituminous Pavement Surface Course

② 3" and variable depth Hot Bituminous Pavement Binder Course (2 @ 1 1/2")

③ 1 1/2" and variable depth Hot Bituminous Pavement Binder Course

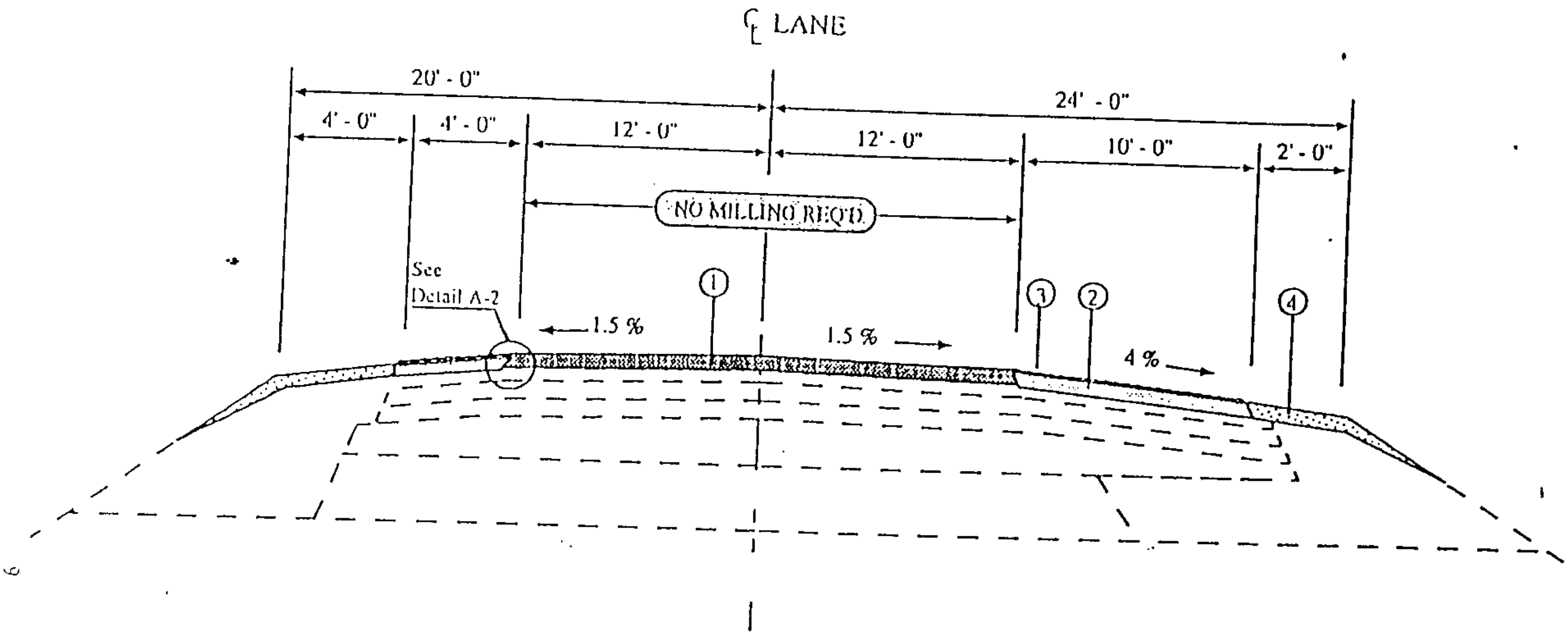
④ 3" Hot Bituminous Pavement Binder Course (2 @ 1 1/2")

⑤ Single Bituminous Surface Treatment

⑥ 4 1/2" and variable depth granular material

– – – Existing pavement structure

Figure 4. SPS-5 section 4, 5 inch AC overlay, no milling.



LEGEND

① 2" Hot Bituminous Pavement Surface Course

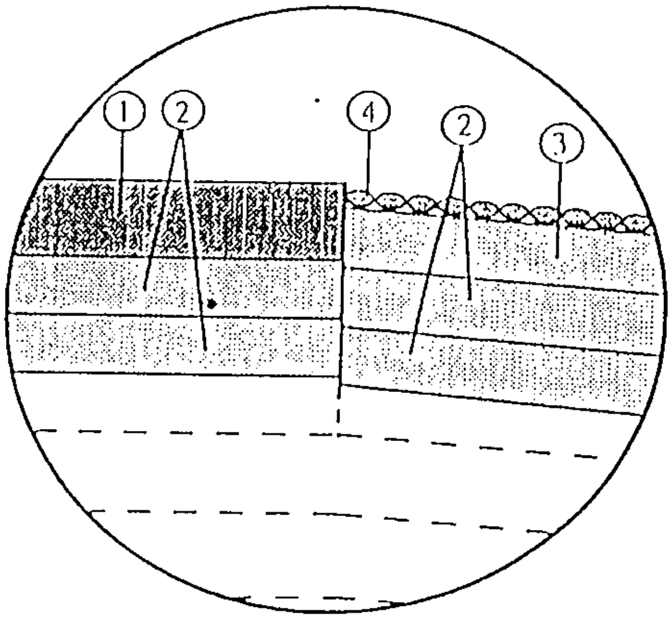
② 1 1/2" and variable depth Hot Bituminous Pavement Binder Course

③ Single Bituminous Surface Treatment

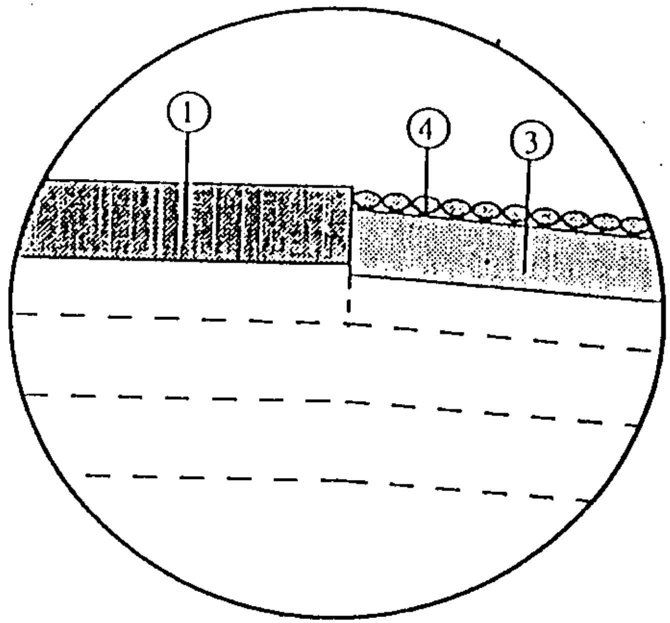
④ 1 1/2" and variable depth granular material

— — — Existing pavement structure

Figure 5. SPS-5 section 5, 2 inch AC overlay, no milling.



Shoulder Detail A-1
Non milled Sections, 5" overlay



Shoulder Detail A-2
Non milled Sections, 2" overlay

LEGEND

1 2" Hot Bituminous Pavement Surface Course

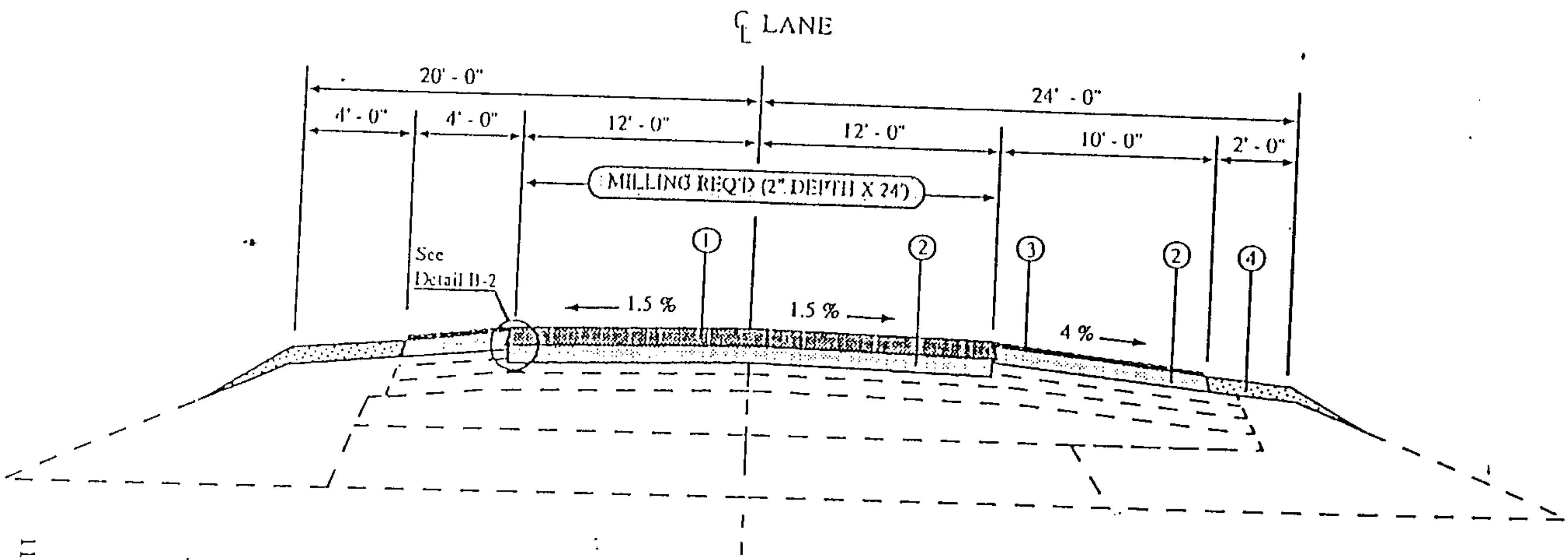
2 3" Hot Bituminous Pavement Binder Course (2 @ 1 1/2")

3 1 1/2" Hot Bituminous Pavement Binder Course

4 Single Bituminous Surface Treatment

— — — Existing pavement structure

Figure 6. Typical shoulder joint detail, non milled sections



LEGEND

① 2" Hot Bituminous Pavement Surface Course

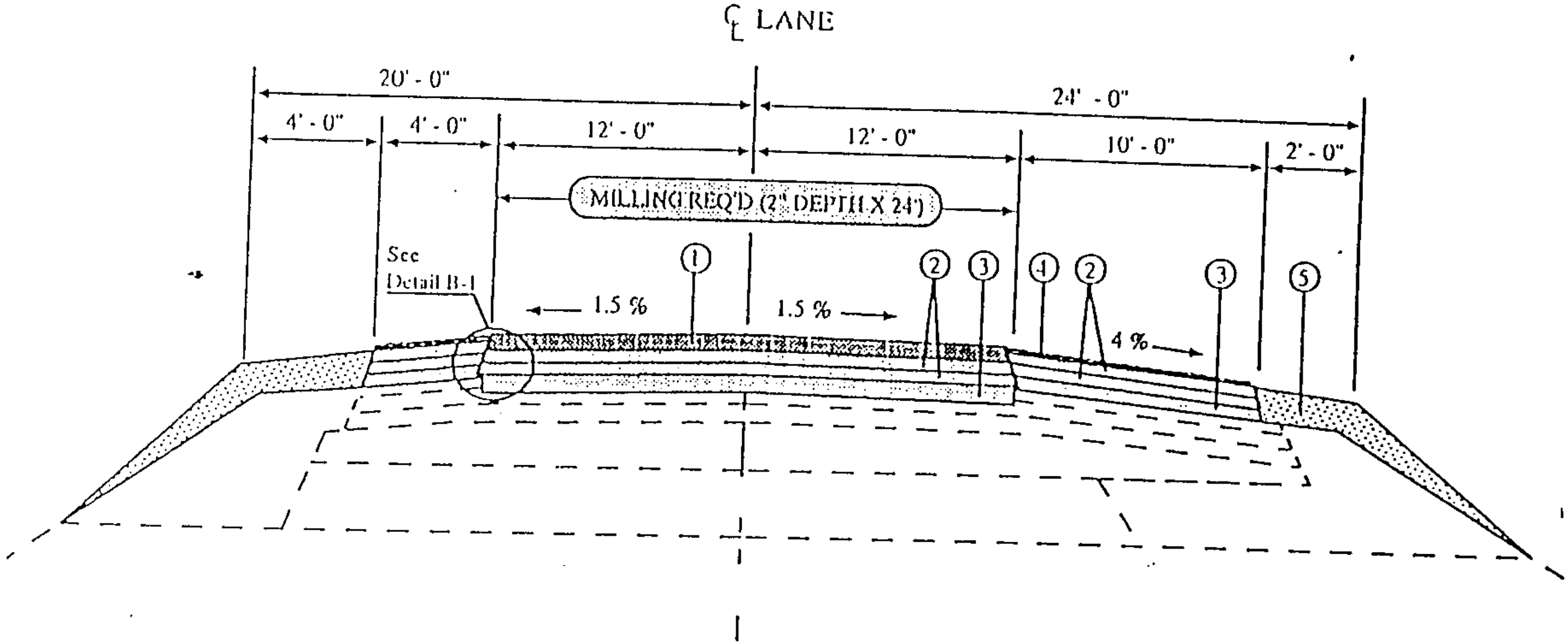
② 2" and variable depth Hot Bituminous Pavement Binder Course

③ Single Bituminous Surface Treatment

④ 2" and variable depth granular material

– – – Existing pavement structure

Figure 7. SPS-5 section 6. 2 inch AC overlay with milling.

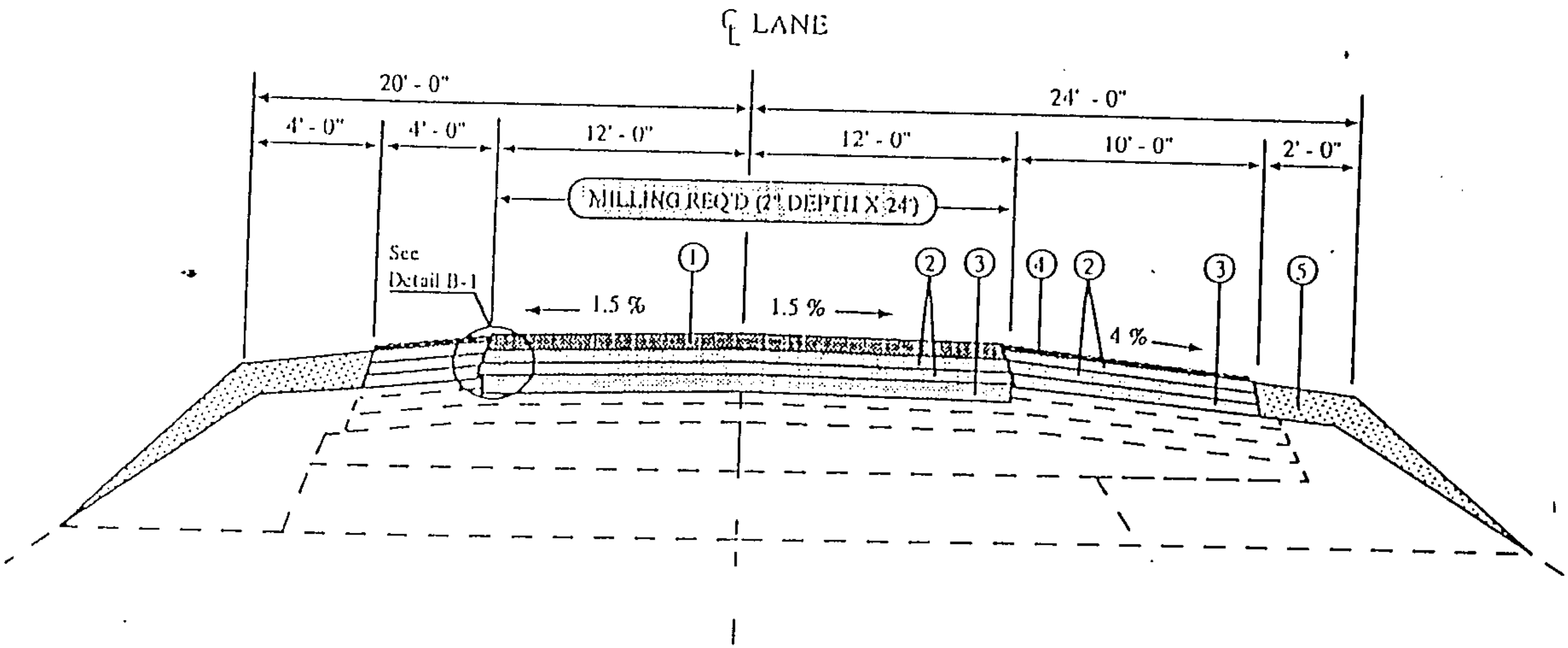


LEGEND

1. 2" Hot Bituminous Pavement Surface Course
2. 3" Hot Bituminous Pavement Binder Course (2 @ 1 1/2")
3. 2" and variable depth Hot Bituminous Pavement Binder Course
4. Single Bituminous Surface Treatment
5. 5" and variable depth granular material

– – – Existing pavement structure

Figure 8. SPS-5 section 7, 5 inch AC overlay with milling.

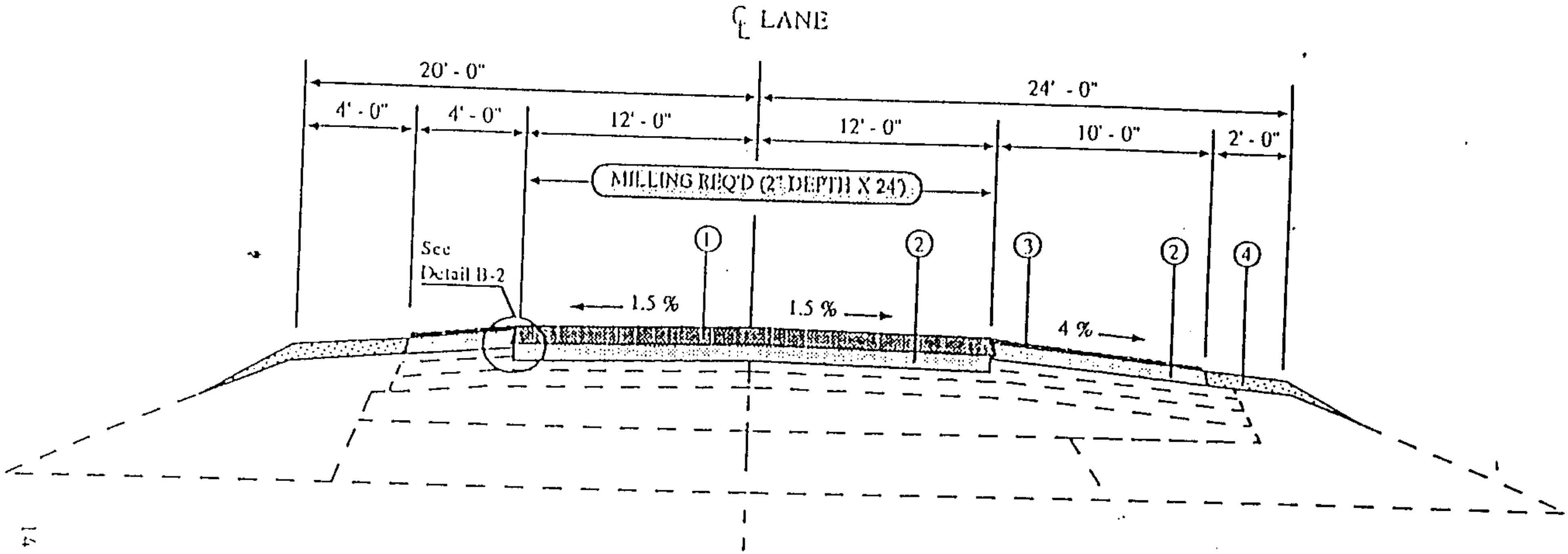


LEGEND

1. 2" Hot Recycled Bituminous Pavement Surface Course
2. 3" Hot Recycled Bituminous Pavement Binder Course (2 @ 1 1/2")
3. 2" and variable depth Hot Recycled Bituminous Pavement Binder Course
4. Single Bituminous Surface Treatment
5. 5" and variable depth granular material

— — — Existing pavement structure

Figure 9. SPS-5 section 8, 5 inch recycled AC overlay with milling.



LEGEND

① 2" Hot Recycled Bituminous Pavement Surface Course

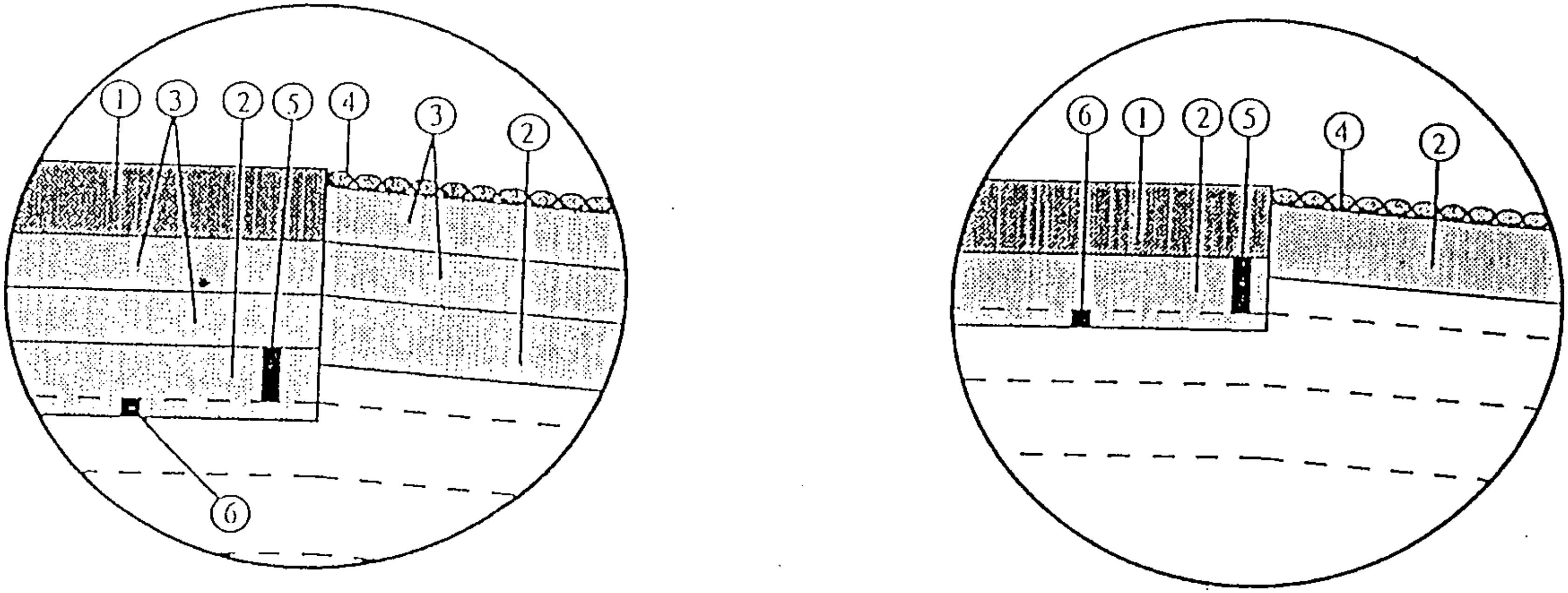
② 2" and variable depth Hot Recycled Bituminous Pavement Binder Course

③ Single Bituminous Surface Treatment

④ 2" and variable depth granular material

– – – Existing pavement structure

Figure 10. SPS-5 section 9, 2 inch recycled AC overlay with milling.



Shoulder Detail B-1
Milled Sections, 5" overlay

Shoulder Detail B-2
Milled Sections, 2" overlay

LEGEND

1. 2" Hot Bituminous Pavement Surface Course
2. 2" Hot Bituminous Pavement Binder Course
3. 3" Hot Bituminous Pavement Binder Course (2 @ 1 1/2")
4. Single Bituminous Surface Treatment
5. 1 1/2" Existing Bituminous Surface Course milled
6. Top 1/2" of Existing Bituminous Binder Course milled

— — — Existing pavement structure

Figure 11. Typical shoulder joint detail, for milled sections.

ACTIVITIES ON CONTROL SECTION

Repairs and other activities on the control test section should be limited to only those maintenance activities needed to keep the section in safe and functional order. Although the project has fallen to a condition level requiring rehabilitation, overlay and extensive repairs on the control section must be avoided at the start of the study. The change in the condition of the control section will be used as an indicator of the change that might be expected in the other test sections if they had not been rehabilitated.

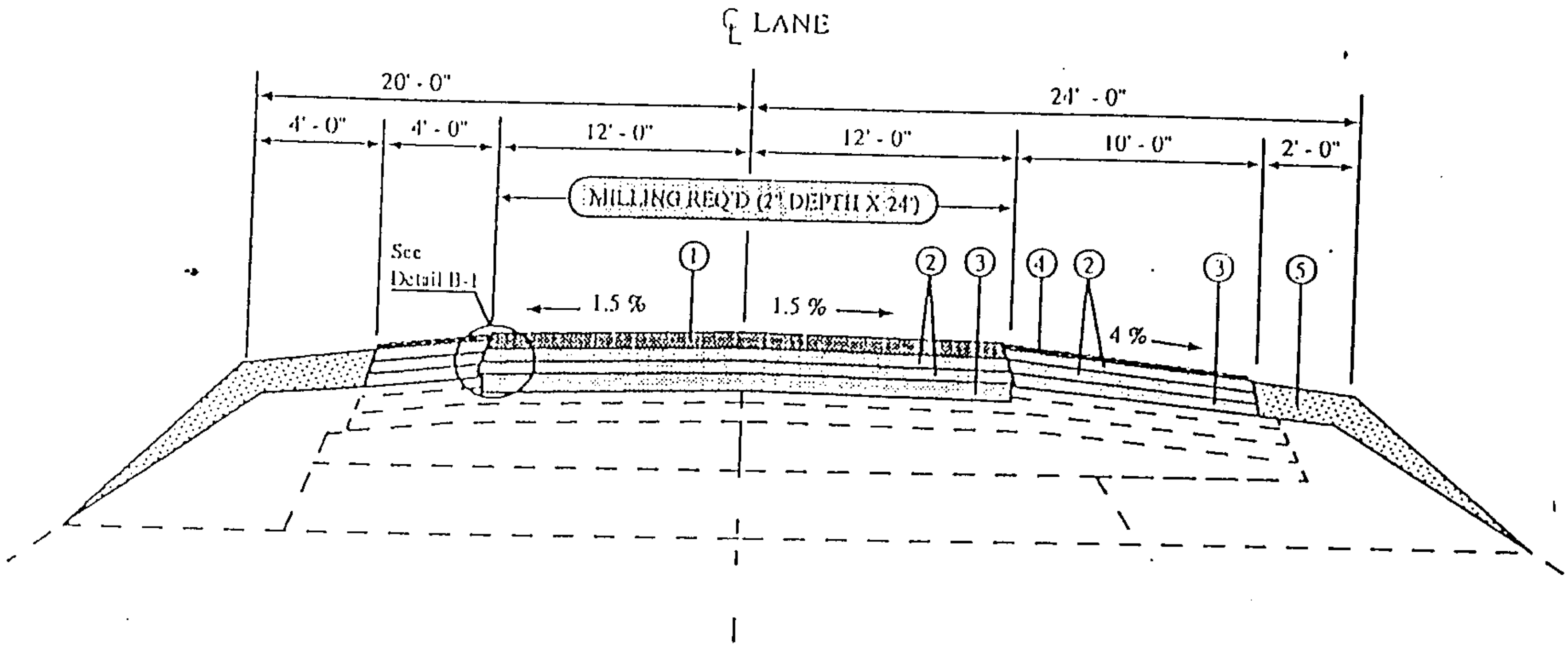
Agencies which routinely use seal coats in their maintenance activities are requested to delay the application of a seal coat on the control section for a minimum of one year from the start of the SPS-5 study, as permitted by existing conditions. This will allow time for two monitoring measurements of the rate of change in the condition of the section.

Those maintenance activities performed on the control test section should be in accordance with the standard procedures of the agency. These procedures may differ from procedures in this document for the overlay test sections.

In general, maintenance treatments on the SPS-5 control section should be limited to those permitted in "Guidelines for Maintenance of General Pavement Studies' (GPS) Test Sections," SHRP-LTPP-OM-001, July, 1988.

PAVEMENT PREPARATION

In the experiment design, preparation of the existing pavement prior to overlay was classed into two levels: minimal and intensive. The objective was to measure the added performance of an overlay due to the intensity of preparation of the existing pavement. Milling of the surface is the most significant difference between the minimal and intensive preparation levels.



LEGEND

① 2" Hot Recycled Bituminous Pavement Surface Course

② 3" Hot Recycled Bituminous Pavement Binder Course (2 @ 1 1/2")

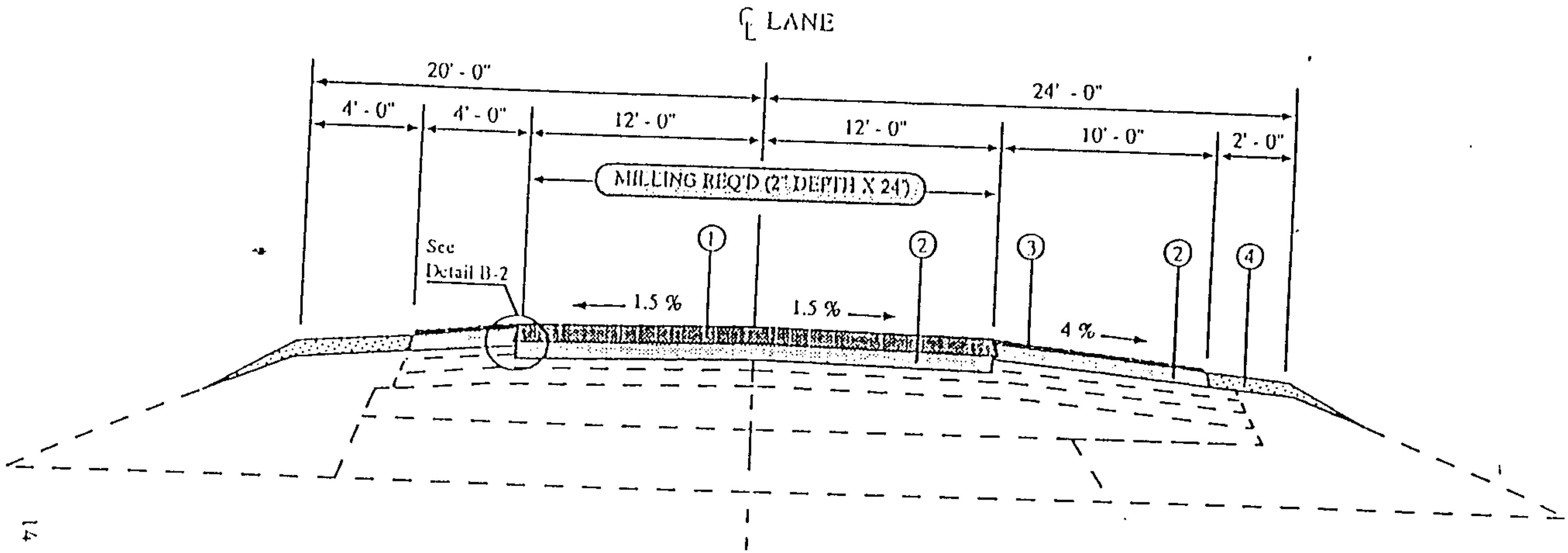
③ 2" and variable depth Hot Recycled Bituminous Pavement Binder Course

④ Single Bituminous Surface Treatment

⑤ 5" and variable depth granular material

– – – Existing pavement structure

Figure 9. SPS-5 section 8, 5 inch recycled AC overlay with milling.



LEGEND

① 2" Hot Recycled Bituminous Pavement Surface Course

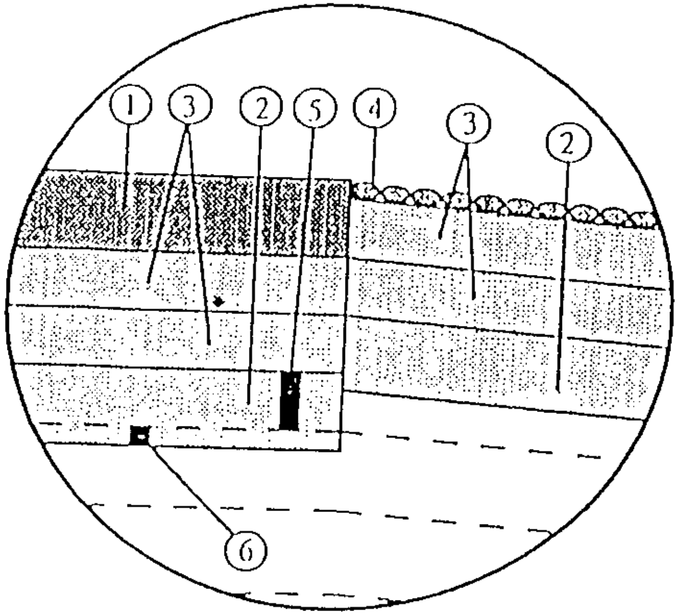
② 2" and variable depth Hot Recycled Bituminous Pavement Binder Course

③ Single Bituminous Surface Treatment

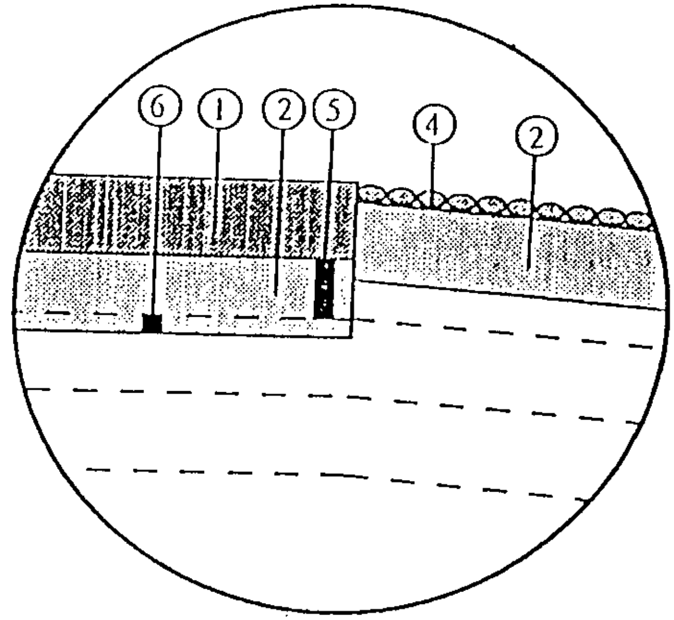
④ 2" and variable depth granular material

– – – Existing pavement structure

Figure 10. SPS-5 section 9, 2 inch recycled AC overlay with milling.



Shoulder Detail B-1
Milled Sections, 5" overlay



Shoulder Detail B-2
Milled Sections, 2" overlay

LEGEND

1 2" Hot Bituminous Pavement Surface Course

2 2" Hot Bituminous Pavement Binder Course

3 3" Hot Bituminous Pavement Binder Course (2 @ 1 1/2")

4 Single Bituminous Surface Treatment

5 1 1/2" Existing Bituminous Surface Course milled

6 Top 1/2" of Existing Bituminous Binder Course milled

— — — Existing pavement structure

Figure 11. Typical shoulder joint detail, for milled sections.

ACTIVITIES ON CONTROL SECTION

Repairs and other activities on the control test section should be limited to only those maintenance activities needed to keep the section in safe and functional order. Although the project has fallen to a condition level requiring rehabilitation, overlay and extensive repairs on the control section must be avoided at the start of the study. The change in the condition of the control section will be used as an indicator of the change that might be expected in the other test sections if they had not been rehabilitated.

Agencies which routinely use seal coats in their maintenance activities are requested to delay the application of a seal coat on the control section for a minimum of one year from the start of the SPS-5 study, as permitted by existing conditions. This will allow time for two monitoring measurements of the rate of change in the condition of the section.

Those maintenance activities performed on the control test section should be in accordance with the standard procedures of the agency. These procedures may differ from procedures in this document for the overlay test sections.

In general, maintenance treatments on the SPS-5 control section should be limited to those permitted in "Guidelines for Maintenance of General Pavement Studies' (GPS) Test Sections," SHRP-LTPP-OM-001, July, 1988.

PAVEMENT PREPARATION

In the experiment design, preparation of the existing pavement prior to overlay was classed into two levels: minimal and intensive. The objective was to measure the added performance of an overlay due to the intensity of preparation of the existing pavement. Milling of the surface is the most significant difference between the minimal and intensive preparation levels.

Minimal Preparation

For the purposes of this experiment, the "minimal" level of pavement preparation consists of:

- Patching of severely distressed areas and potholes.
- Crack sealing
- Leveling course if ruts ≥ 1 inch are present.

Milling, edge drain installation or restoration, geometric corrections, seal coats (chip, fog, slurry) and use of geotextiles are not permitted on the minimal preparation test sections (sections 2-5).

Patching. Patching of the minimal preparation test section should be limited to potholes, areas with severe fatigue cracking, and other deteriorated areas requiring deep (≥4 inches) patching. The following guidelines should be observed for patching of the minimal preparation test sections:

- Vertical cuts, rectangular in shape, shall be made at the edges of all patches. These cuts should be a minimum of 4" deep and should extend to a depth necessary to reach sound material.
- A prime coat should be applied to granular base material or subgrade in the bottom of the patch. Vertical faces of the patch should be tack coated.
- Dense graded Hot Mixed Asphalt Concrete patching mixture shall be used for all full depth patches.
- The material should be placed in lifts and well compacted flush with the surface using either a vibratory plate compactor, roller compactor, or other mechanical compactor suitable for the size of the patch.
- Patches shall be allowed to cure at least one hour prior to opening to traffic or placement of the overlay.

Crack Sealing. The following guidelines should be followed for sealing of cracks:

- All cracks with nominal widths between 1/8" and 3/4" should be sealed. Cracks wider than 3/4" should be repaired (ie. patched). Cracks less than 1/8" should not be sealed.

- Perform crack sealing after patching operations are completed. This avoids sealing areas removed during patching and allows sealing of cracks which intersect or are adjacent to patched areas.

- All cracks 1/8" to 3/4" wide with spalled or ravelled edges shall be routed approximately 1/4" wider than the nominal crack width. All transverse cracks greater than 1/4" shall be routed. Route depth should be between 1 to 2 times the routed crack width.

- Routed cracks with a depth to width shape factor ratio greater than 1.5 should have a non reactive, non absorbent backer rod, 1/8" wider than the routed crack width, inserted prior to sealing.

- All cracks should be cleaned and prepared using a compressed air heat lance.

- Crack sealing shall only be performed when the air and pavement temperatures exceed 45°F.

- Rubber asphalt sealant meeting AASHTO M-173-60 shall be used.

- Cracks shall be sealed flush with the surface and sanded. Any excess sealant or sand shall be removed.

- Freshly sealed cracks should be "cured" for a minimum of 1 hour prior to opening to traffic or placement of overlay.

Leveling Course. An asphaltic concrete leveling course shall be placed in ruts greater than 1" deep prior to overlay. This is only intended to fill the ruts and not to cover other areas.

Intensive Preparation

The intensive level of preparation for test sections 6-9 includes:

- Patching of distressed areas and potholes
- Milling
- Crack Sealing
- Longitudinal Edgedrains

The application of seal coats (chip, fog, slurry) and geotextiles are prohibited on these sections.

Patching. In addition to the patching guidelines presented for minimal pavement preparation, the following guidelines should also be observed for the test section designated for intensive preparation (sections 6-9):

- Full depth patching shall be performed at all locations with potholes, high severity cracking, and other severely distressed areas. Shallow surface defects which will be removed by the milling operation need not be patched.

- Existing patches which have deteriorated or exhibit bleeding, scaling, or severe cracking should be removed and patched following the patching guidelines in this document.

- Patches shall be placed prior to milling.

- Patches shall be allow to cure at least 1 hour prior to milling.

Crack Sealing. Cracks still existing after milling shall be sealed in accordance with the crack sealing guidelines presented under minimal preparation.

Longitudinal Edgedrains. Retro-fitted longitudinal edge drains are not required on the intensive preparation test sections, but are permitted in those instances where they are deemed necessary by the participating agency. Restoration of existing edgedrains are also permitted along these test sections as deemed necessary by the participating agency. If edgedrains are installed or restored on any of the intensive preparation test sections, they should be installed or restored on all of these test sections (sections 6-9).

Agencies should consider the following factors in their determination of the need for installation of edgedrains:

- Condition of the pavement.
- Pavement age.
- Accumulated axle loadings or axle loading rate.
- Annual precipitation.
- Lateral transmissibility of the base layer beneath the pavement surface.
- Frost penetration.

It is desired that edgedrains only be installed on projects for which there is a demonstrated need. Agencies who have determined that edgedrains are required on the project site should contact their SHRP representative to discuss their plans.

Milling. Milling of the pavement surface should be performed on the intensive preparation test sections (sections 6-9) only. Milling should not begin until all patches have cured for a minimum of 1 hour after compaction. The following guidelines shall be observed:

- Milling shall be performed to a depth between 1/2" to 2" to remove any oxidized or stripped material from the surface, ruts, and any seal coats or open graded friction courses. The milled depth should not occur at an interface between material layers.

- Milling equipment must be able to maintain an accurate depth of cut, profile and cross slope. Automatic profile controls must be provided which employ a floating beam or skid with a minimum length of 30 feet. The cutting head shall be a minimum width of 6 feet and be capable of full drum width milling.

- The pavement surface shall be milled such that the transverse cross slope is restored to initial specifications, or to that deemed acceptable by agency standards.

- The milling equipment should be operated to provide a uniform texture with no ridges or low spots and to minimize tearing or breaking of the underlying and adjacent pavement surfaces.

- Milled materials shall be loaded directly from the milling machine and removed.

- Full depth milling shall extend a minimum of 25 feet into the transition zones at the beginning and end of the milled test sections.

- The start and end of the milled areas shall be feathered to avoid drop offs no greater than 1/2" in 10 feet longitudinally.

- The milled surface shall be cleaned with a power broom prior to crack sealing or placement of the tack coat.

SPECIAL CONSIDERATIONS

The following treatments are specifically not to be performed on any of the test sections:

- Lane widening. Widening will alter the characteristics and behavior or performance of the sections and thus "confound" the factors and effects to be evaluated.

- Seal coats (Chip, fog, slurry). Seal coats are generally considered as preventive maintenance treatments designed to alter the rate of deterioration of the pavement. Although some agencies place a seal coat as a part of the surface preparation process prior to overlay, it was the consensus of the agency representatives participating in the design workshop not to include seal coats as a factor in this experiment. This factor is being evaluated in the SPS 3 study of preventive maintenance techniques.

- Geotextiles. The use of geotextiles were also not included as a main factor in this experiment. They have been included by some agencies in supplemental test sections on the SPS-5 projects.

The foregoing exclusions are not meant to detract from the importance of these treatments in asphalt pavement rehabilitation. Rather, the SPS-5 experiment was designed to evaluate other main factors. The inclusion of such factors as geotextiles or lane widening on an uncontrolled basis would serve to diminish the results of this experiment and confound measurement of the main factors included in the experiment design. Their inclusion into the experiment would require doubling the size of the experiment to properly study each added factor.

The following are other special situations or treatments which need to be considered:

- Surface friction courses. Some agency's require the use of surface friction courses. Their inclusion is therefore necessary on test sections within their jurisdiction. In these instances, the thickness of the friction course should be limited to 1.5" or less. The thickness of the friction course will not be considered as part of the thickness of the dense graded overlay.

- Stripped surfaces. If stripping is present on the control section, and if the agency routinely applies chip, fog, or slurry seals in such cases, then that treatment is permissible. If conditions permit, the application of a seal coat to the control sections should be delayed one year from the start of the SPS-5 study. Seal coats are not to be applied on test sections with a minimal level of preparation (sections 2-5). Any severe ravelling associated with stripping should be repaired with a surface patch on the minimal preparation test section. Any stripping of the pavement surface present on the intensive preparation test sections should be removed by the milling operation.

ASPHALT CONCRETE MIX DESIGN

The generic type of hot mixed asphalt concrete material used in the overlays is a main factor in the SPS 5 experiment. Mixtures composed of "virgin" materials (all new) and those containing a portion of recycled asphalt concrete materials are the two chosen levels for this factor.

It is not practical or feasible to specify either the same mix, mix design, or even mix design method at all test locations. To promote uniformity across agencies, design of the asphaltic concrete mixes shall be performed in compliance with the guidelines contained in the FHWA Technical Advisory T5040.27. A copy of these guidelines are reproduced in Appendix A of this report. The guide design indices presented in this Advisory for Marshall and Hveem design procedures should be followed to achieve dense graded asphalt concrete mixtures designed to approximately equivalent specifications. Agencies using non-standard Hveem or Marshall mix design procedures, should design mixes which achieve equivalent design indices obtained using these standard procedures.

Virgin Materials

The asphalt concrete designated as "virgin" shall employ new materials which have not been used in previous construction.

Aggregates. Aggregates used in the virgin mixes shall be new aggregates of the highest quality available to the agency. These aggregates shall conform to the following guidelines:

- A minimum of 50% crushed material is required.
- A minimum sand equivalent test of 45 should be obtained following AASHTO T176.
- The aggregate shall have a maximum abrasion loss of 9% at 100 revolutions and 40% ar 500 revolutions when tested in accordance with AASHTO T 96.
- A dense aggregate gradation shall be used to produced a mix conforming to the Hveem or Marshall mix design requirements specified in the FHWA Advisory.

Asphalt Cement. The asphalt grade and characteristics should be selected by the agency based on normal practice.

<u>Additives</u>. Additives, such as lime, which are routinely used by an agency are permitted in the mix design. The use of experimental additives or modifiers are restricted to supplemental test sections.

<u>Recycled Materials</u>

The asphaltic concrete mix containing recycled asphalt concrete materials shall conform to the following guidelines:

- A fixed 30% of recycled asphalt pavement (RAP) shall be used in the mixture.
- The RAP shall be free of organic, deleterious, or weak material.
- RAP containing poor quality aggregates with a history of stripping or high abrasion should not be used.
- All reclaimed coarse aggregate material shall have 100% passing the 1½" sieve and a maximum of 25% passing the 3/8" sieve.
- Reclaimed crushed fines shall have 100% passing the 3/4" sieve and no more than 25% retained on the 3/8" sieve.
- Measurement of the composition of the RAP including aggregate gradation, asphalt content, asphalt viscosity (@ 140 and 275° F), ductility and penetration at 77° F should be performed for proper design of the recycle mix.
- New aggregate specifications shall conform to those required for the virgin mix.
- A softer grade of asphalt cement, obtained from the same source or supplier as the virgin mix binder, should be used to obtain a combined

binder with penetration and viscosity characteristics as similar to the virgin mix binder as possible.

- Rejuvenating agents are not permitted in the recycled mix design.

- The use of asphalts with low temperature susceptibility (PVN value $\geq$ -0.5) are recommended.

- The recycled mix shall be designed to the same mix design indices as the virgin mix. This includes, flow, stability, air voids, VMA, etc., as provided in the FHWA Technical Advisory T5040.27.

CONSTRUCTION OPERATIONS

Construction operations shall be performed in compliance with the guidelines presented in the FHWA Technical Advisory and be representative of high quality construction practice employed by the participating agency. Adequate attention to details and control of mix plant, hauling, placement and compaction operations must be maintained on the test sections. Care should be taken to prevent excessive attention to the construction of the test sections to the extent that they are not representative of normal highway practice. The objective of construction control on the test section is to prevent construction practices which are known to result in limited performance.

The following construction related guidelines shall be followed:

- Lift thicknesses shall be limited to 2.5".

- The asphalt concrete mix shall be placed only after the contractor has satisfactorily demonstrated proper placement and compaction procedures on non-test section locations.

- Tack coats shall be composed of diluted CSS-1, CSS-1h, SS-1, or SS-1h type emulsions. One part water shall be added to one part emulsion, in this order.

- Longitudinal joints shall be located within 1 foot of the center of a lane or within 1 foot of the center of two adjacent lanes.

- All transverse joints construction joints shall be placed within the transition between test sections.

- The as-compacted thickness of the asphalt concrete overlay (surface plus binder course) in the test sections shall be constructed to within ± 1/4" of the values specified in the experiment design (ie. 2" & 5").

- The finished surface of the overlay on all sections shall not deviate more than 1/8" from the lower edge of a 10 foot straight edge placed parallel to the center line of the roadway 3 feet inside either the outside edge of the lane or the approximate location of the planned lane marking. Alternatively, the profile index shall be less than 10 inches per mile as measured by a California type Profilograph and evaluated conforming with California Test 526.

WHY NOT GIVE GUID. MATCHING SHIFTS PER

DEVIATIONS FROM GUIDELINES

All out-of-specification test sections must be either removed and replaced, or the test section moved to a location conforming to the required specifications. Out-of-specifications includes materials, mixtures, surface preparation, and construction operations which deviate from the required guidelines.

Agencies which can not meet the guidelines presented in this document should contact their local SHRP representative to investigate other approaches and to asses the potential impact of non-conformance on the overall experiment results.

APPENDIX A

ASPHALT CONCRETE MIX DESIGN AND FIELD CONTROL

FHWA Technical Advisory T 5040.27

March 10, 1988.

DRAFT

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

SUBJECT

ASPHALT CONCRETE MIX DESIGN AND FIELD CONTROL

FHWA TECHNICAL ADVISORY
T 5040.27
March 10, 1988

Par. 1. Purpose
2. Cancellation
3. Background
4. Materials
5. Mix Design
6. Plant Operations
7. Laydown and Compaction
8. Miscellaneous

1. PURPOSE. To set forth guidance and recommendations relating to asphalt concrete paving, covering the areas of materials selection, mixture design, and mixture production and placement. The procedures and practices outlined in the Technical Advisory (TA) are directed primarily towards developing quality asphalt concrete pavements for high-type facilities. The TA can also be used as a general guide for low-volume facilities.

2. Cancellation. Federal Highway Administration (FHWA) Technical Advisory T 5040.24, Bituminous Mix Design and Field Control, dated August 22, 1985, is cancelled.

3. BACKGROUND

a. Over one-half of the Interstate System and 70 percent of all highways are paved with hot-mix asphalt concrete. Asphalt concrete is probably the largest single highway program investment today and there is no evidence that this will change in the near future. However, there is evidence that the number of premature distresses in the nation's recently constructed asphalt pavements is increasing. Heavier truck axle weights, increased tire pressures, and inadequate drainage are some of the factors leading to the increase in premature distress. The FHWA has been concerned with the deterioration in quality of asphalt concrete pavements for many years and in 1987 a special FHWA Ad Hoc Task Force studied two of the most common distresses existing today and subsequently issued a report titled "Asphalt Pavement Rutting and Stripping." The report contained both short-term and long-term recommendations for improving the quality of asphalt pavements.

b. With the variables of environment, component materials, and traffic loadings found throughout the United States, it is not surprising that there are many State-to-State or regional variations of design and construction requirements. No one set of specifications can achieve the same results in all States because of the factors mentioned above. However, there are many things that States can do to improve their current mix design and field control procedures to ensure that quality asphalt pavements will be constructed. This TA incorporates many of the FHWA Task Force recommendations and presents the current

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state-of-the-art in materials, mix design, plant operation, laydown and compaction, and other areas relating to quality hot-mix asphalt pavements.

4. MATERIALS

a. Aggregate is the granular material used in asphalt concrete mixtures which make up 90-95 percent of the mixture weight and provides most of the load bearing characteristics of the mix. Therefore, the quality and physical properties of the aggregates are critical to the pavement performance. The following is recommended:

(1) Aggregates should be non-plastic. The presence of clay fines in an asphalt mix can result in problems with volume swell and adhesion of asphalt to the rock contributing to stripping problems. The minus #4 sieve material should have a minimum sand equivalent value of 45 using the test method described in the American Association of State Highway and Transportation Officials (AASHTO) specification (AASHTO T176).

(2) A limit should be placed on the amounts of deleterious materials permitted in the aggregates. Specifications should limit clay lumps and friable particles to a maximum of one percent.

(3) Durability or weathering resistance should be determined by sulfate soundness testing. Specifications should require a sodium or magnesium sulfate test using the limits described in the AASHTO specification M29.

(4) Aggregate resistance to abrasion should be determined. Specifications should require a Los Angeles abrasion loss of 45 percent or less (AASHTO T96).

(5) Friction between aggregate particles is dependent on aggregate surface roughness and area of contact. As surface friction increases, so does resistance of the mix to deformation. Specifications should require at least 60 percent of the plus #4 sieve material to have at least two mechanically induced fractured faces.

(6) The quality of natural sand varies considerably from one location to another. Since most natural sands are rounded and often contain a high percentage of undesirable materials, the amount of natural sand as a general rule should be limited to 15 to 20 percent for high volume pavements and 20 to 25 percent for medium and low volume pavements. These percentages may increase or decrease depending on quality of the natural sand and the types of traffic to which the pavement will be subjected.

(7) For adequate control, aggregate gradations should be specified from the maximum particle size to the #200 sieve so each successive sieve opening is about 1/2 the previous sieve opening (for example, 1 inch, 1/2 inch, #4, #8, #16, #30, #50, #100, #200). The only accurate method to determine the amount of minus #200 sieve material is to perform a wash gradation in accordance with AASHTO T27 and AASHTO T11.

(8) The ratio of dust (minus #200 sieve material) to asphalt cement, by mass, is critical. Asphalt concrete mixes should require a maximum dust asphalt ratio of 1.2 and a minimum of 0.6.

(9) A tool which is very useful in evaluating aggregate gradations is the 0.45 power gradation chart. All mixes should be plotted on these charts as part of the mix design process (Attachment 1).

(10) An aggregate's specific gravity and absorption characteristics are extremely important in proportioning and controlling the mixture. It is recommended that AASHTO T209 be used to determine the maximum specific gravity of asphalt concrete mixes. States not using AASHTO T209 should be aware of the difficulty of determining the theoretical maximum density using individual ingredient specific gravities and their percentages in the mixture. These difficulties will result in inaccuracies in determining the specific gravity of the mixture. These inaccuracies will carry through to the calculation of the densities in the compacted mat and may result in improperly compacted pavements. It is also necessary to determine the bulk dry specific gravity of the aggregate in order to determine the voids in the mineral aggregate (VMA).

The target value for VMA should be obtained through the proper distribution of aggregate gradation to provide adequate asphalt film thickness on each particle and accommodate the design air void system. In addition, tolerance used in construction quality control should be such that the mix designed is actually produced in the field.

b. Asphalt grade and characteristics are critical to the performance of the asphalt pavement. The following is recommended:

(1) Grade(s) of asphalt cement used in hot-mix paving should be selected based on climatic conditions and past performance.

(2) It is recommended that asphalt cement be accepted on certification by the supplier (along with the testing results) and State project verification samples. Acceptance procedures should provide information on the physical properties of the asphalt in a timely manner.

(3) The physical properties of asphalt cement that are most important to hot-mix paving are shown below. Each State should obtain this information (by central laboratory or supplier tests) and should have specification requirement(s) for each property except specific gravity.

(a) Penetration 77° F

(b) Viscosity 140° F

(c) Viscosity 275° F

(d) Ductility/Temperature

(e) Specific Gravity

(f) Solubility

(g) Thin Film Oven (TFO)/Rolling TFO; Loss on Heating

(h) Residue Ductility

(i) Residue Viscosity

(j) Low temperature cracking is related to the physical properties of the asphalt and may be increased by the presence of wax in the asphalt. The low temperature ductility test at 39.2° F (4° C) can indicate where this may be a problem. The test is performed at a pull speed of 1 cm/min. Typical specification requirements are:

AASHTO M226	Table 2
AC 2.5	50 + cm
AC 5	25 + cm
AC 10	15 + cm
AC 20	5 + cm

(4) The temperature viscosity curves or absolute and kinematic viscosity information should be available at the mixing plant for each shipment of asphalt cement. This can identify a change in asphalt viscosity which necessitates a new mix design. Each State should provide temperature/viscosity information on the asphalt used in the laboratory mix design to the projects. Differences in the viscosity (as well as the penetration) of the asphalt from the asphalt used in the mix design may indicate the necessity to redesign the mix (Attachment 2).

5. MIX DESIGN

a. Asphalt concrete mixes should be designed to meet the necessary criteria based on type of roadway, traffic volumes, intended use, i.e., overlay on rigid or flexible pavements, and the season of the year the construction would be performed. Each State's mix design criteria should be as follows.

Property	Heavy Traffic Design (>1,000,000 ESAL*)	Medium Traffic Design (10,000-1,000,000 ESAL)	Light Traffic Design (<10,000 ESAL)
Marshall			
Compaction Blows	75	50	35
Stability (min.)	1,500	750	500
Flow	8-16	8-18	8-20
Hveem			
Stability (min.)	37	35	30
Swell	0.030 in.	0.030 in.	0.030 in.
Void Analysis			
Air Voids	3-5	3-5	3-5

* Equivalent Single Axle Load

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MINIMUM PERCENT VOIDS IN MINERAL AGGREGATE (VMA)

Nominal Maximum Particle Size U.S.A. Standard Sieve Designation	Minimum Voids in Mineral Aggregate Percent
No. 16	23.5
No. 8	21
No. 4	18
3/8 in.	16
1/2 in.	15
3/4 in.	14
1 in.	13
1-1/2 in.	12
2 in.	11.5
2-1/2 in.	11

b. Standard mix design procedures (Marshall, Hveem) have been developed and adopted by AASHTO, however, some States have modified these procedures for their own use. Any modification from the standard procedure should be supported by correlation testing for reasonable conformity to the design values obtained using the standard mix design procedures.

c. Stripping in the asphalt pavements is not a new phenomenon, although the attention to it has intensified in recent years. Moisture susceptibility testing should be a part of every State's mix design procedure. The "Effect of Water on Compacted Bituminous Mixtures" (immersion compression test) (AASHTO T165) and "Resistance of Compacted Bituminous Mixture to Moisture Induced Damage" (AASHTO T283) are currently the only stripping test procedures which have been adopted by AASHTO. The AASHTO T283, commonly known as the Lottman Test, requires that the test specimens be compacted so as to have an air void content of 7 ± 1 percent, while AASHTO T165 does not. This air void content is what one would expect in the mat after construction compaction. There is considerable research underway on developing better tests for determining moisture damage susceptibility of the aggregate asphalt mixtures. One of the most promising test procedures is that developed by Tunnicliff and Root as reported in the National Cooperative Highway Research Program (NCHRP) Report 274. This test is similar to AASHTO T283, but it takes less time to perform. In the majority of cases hydrated lime and portland cement have proven to be the most effective anti-stripping additives.

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d. The determination of air voids in the laboratory mix is a critical step in designing and controlling asphalt hot-mix. In order to determine air voids, the theoretical maximum density or the maximum specific gravity of the mix must be determined. This can be accomplished by using the "Maximum Specific Gravity of Bituminous Paving Mixtures" (Rice Vacuum Saturation) (AASHTO T209).

e. Proper mix design procedures require that each mix be designed using all of the actual ingredient materials including all additives which will be used on the project.

f. The complete information on the mix design should be sent to the plant. The following information should be included in the mix design report and sent to the plant.

(1) Ingredient materials sources

(2) Ingredient materials properties including:

(a) Specific gravities

(b) L. A. Abrasion

(c) Sand equivalent

(d) Plastic Index

(e) Absorption

(f) Asphalt temperature/viscosity curves or values

(3) Mix temperature and tolerances

(4) Mix design test property curves

(5) Target asphalt content and tolerances

(6) Target gradations for each sieve and tolerances

(7) Plot of gradation on the 0.45 power gradation chart, and

(8) Target density

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g. Formal procedures should be established to require that changes to mix designs be approved by the same personnel or office that developed the original mix design.

h. After start-up, the resulting mixture should be tested to verify that it meets all of the design criteria.

6. PLANT OPERATIONS

a. In order to assure proper operation, an asphalt plant must be calibrated and inspected. Plant approval should be required and should cover each item on the asphalt plant checklist (Attachment 3).

b. To avoid or mitigate unburned fuel oil contamination of the asphalt mixture, the use of propane, butane, natural gas, coal or No. 1 or No. 2 fuel oils is recommended.

c. If the asphalt cement is overheated or otherwise aged excessively, the viscosity of the recovered asphalt will exceed that of the original asphalt by more than four times. However, if the viscosity of the recovered asphalt is less or even equal to the original viscosity, it has probably been contaminated with unburned fuel oil.

d. For drum mixer and screenless batch plants there should be three separate graded stockpiles for surface courses and four for binder and base courses. Each stockpile should contain between 15 to 50 percent by weight of the aggregate size in the mix design. The plus #4 sieve aggregate stockpile should be constructed in lifts not exceeding 3 feet to a maximum height of 12 feet. There should be enough material in the stockpiles for at least 5 days of production. The plant should be equipped with a minimum of four cold feed bins with positive separation.

e. Control testing of gradation and asphalt content should be conducted to assure a quality and consistent mixture. In many States, the contractor or supplier is required to do this testing.

f. Acceptance testing should be conducted for gradation and asphalt content of the final mixture.

g. The plotting of control and acceptance test results for gradation, asphalt content, and density on control charts at the plant provides for easy and effective analysis of test results and plant control.

h. The moisture content of the aggregate must be determined for proper control of drum mixer plants. The asphalt content is determined by the total weight of the material that passes over the weigh bridge with the correction made for moisture. Sufficient aggregate moisture contents need to be performed throughout the day to avoid deviations in the desired asphalt content.

i. Moisture contents of asphalt mixtures is also important. The extraction and nuclear asphalt content gauge procedures will count moisture as asphalt. For this reason, a moisture correction should be made. In addition, high moisture contents in asphalt mixtures can lead to compaction difficulty due to the cooling of the mix caused by evaporation of the moisture. This is particularly important with drum mixer mixes which require moisture for the mixing process. Some States specify a maximum moisture content behind the paver. A recommended maximum moisture content behind the paver is 0.5 percent.

7. LAYDOWN AND COMPACTION

a. Prior to paving start-up, equipment should be checked to assure its suitability and proper function. Project equipment approval should include the items shown on the project inspection checklist (Attachment 4).

b. Paving start-up should begin with a test strip section. This will allow for minor problems to be solved, establishment of roller patterns and number of passes, and will assure that proper placement and compaction can be attained.

c. In order to assure proper placement and compaction, it is essential that the mat be placed hot. Establishment of and compliance with the following items should be included; minimum mix, underlying pavement, and ambient temperatures. Cold weather and early or late season paving should be avoided. The practice of raising the temperature of the mixture to combat the cold conditions should not be permitted, as this will contribute to excessive aging of the asphalt cement.

d. The use of a pneumatic roller in the compaction process is strongly encouraged. When used in the intermediate rolling it will knead and seal the mat surface and aid in preventing the intrusion of surface water into the pavement layers. It will also contribute to the compaction of the mat.

e. Density requirements should be established to result in an air void system in the mat of 6-8 percent immediately after construction. This allows for the inherent additional densification under traffic to an ultimate air void content of about 3-5 percent. Density acceptance specifications should require a percentage of maximum density as determined by AASHTO T209. A percentage of test strip density or Marshall laboratory density can be used provided each is related to the maximum density. The specified density should be attained before the mat temperature drops below 175° F.

f. Density measurement should be accurate, taken frequently, and the results made available quickly for each day of production. Density should be determined by test cores, or by properly calibrated nuclear test gauges. Specifications should require several tests to be averaged to determine density results for acceptance.

g. Successive hot-mix courses should not be placed while previous layers are wet. To avoid, or minimize the penetration of water into base and binder courses, paving operations should be scheduled so that the surface layer(s) is placed within a reasonable period after these courses are constructed. To the greatest extent possible, construction should be planned to avoid the necessity of leaving layers uncovered during wet seasons of the year.

8. <u>MISCELLANEOUS</u>

a. Some States have established procedures to accept out-of-specification material and pavement with a reduction in price. These procedures include definition of lot size/production time, tolerances, and pay factor reductions for ingredient materials, combined mixture properties, pavement density, pavement smoothness, and lift thickness.

b. Prior to the start of production and placement operations, a preplacement conference, including all the paving participants, should be held. This conference would define duties and responsibilities for each phase of the operation as well as problem solving procedures.

c. During start-up it is very effective to have a construction and/or materials specialist at the project site to assist in identifying and solving any problem that develops.

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d. Because asphalt hot-mix pavement construction is complex, it requires that each person involved understand his/her function thoroughly. It is also helpful if each person has a basic understanding of each of the many phases involved. It is recommended that States develop or use existing training to address these phases of asphalt paving.

Ronald E. Heinz
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Associate Administrator for
Engineering and Program Development

4 Attachments

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FHWA TECHNICAL ADVISORY T 5040.27
March 10, 1988
ATTACHMENT 1

AGGREGATE GRADATION

It has long been established that gradation of the aggregate is one of the factors that must be carefully considered in the design of asphalt paving mixtures, especially for heavy duty highways. The purpose in establishing and controlling aggregate gradation is to provide sufficient voids in the asphalt aggregate mixture to accommodate the proper asphalt film thickness on each particle and provide the design air void system to allow for thermal expansion of the asphalt within the mix. Minimum voids in the mineral aggregate (VMA) requirements have been established and vary with the top aggregate size.

Traditionally, gradation requirements are so broad that they permit the use of paving mixtures ranging from coarse to fine and to either low or high stability. To further complicate matters, different combinations of sieve sizes are specified to control specific grading ranges. Standardization of sieve sizes and aggregate gradations, which has often been suggested, is not likely to occur because of the practice of using locally available materials to the extent possible.

In the early 1960's, the Bureau of Public Roads introduced a gradation chart (Figure #1) which is especially useful in evaluating aggregate gradations. The chart uses a horizontal scale which represents sieve size openings in microns raised to the 0.45 power and a vertical scale in percent passing. The advantage in using this chart is that, for all practical purposes, all straight lines plotted from the lower left corner of the chart, upward and toward the right to any specific nominal maximum particle size, represent maximum density gradations. The nominal maximum particle sieve size is the largest sieve size listed in the applicable specification upon which any material is permitted to be retained. An example is shown in Figure #2.

The gradations depicted in Figure #3 and #4 are exaggerated to illustrate the points being made. By using the chart, aggregate gradations can be related to maximum density gradation and used to predict if the mixture will be fine or coarse textured as shown in Figure #3.

Soon after the chart was developed, it was used to study gradations of aggregate from several mixtures that had been reported as having unsatisfactory compaction characteristics. These mixtures could not be compacted in the normal manner because they were slow in developing sufficient stability to withstand the weight of the rolling equipment. Such mixtures can be called "tender mixes." This study identified a consistent gradation pattern in these mixes as is illustrated in Figure #4.

Most notable is the hump in the curve near the #40 sieve and the flat slope between the #40 sieve and the #8 sieve. This indicates a deficiency of material in the #40 to 8# sieve range and an excess of material passing the #40 sieve. Mixtures with an aggregate exhibiting this gradation characteristic are susceptible to being tender, particularly if the fines are composed of natural sand.

As part of the bituminous mix design process, the aggregate gradation should be plotted on the 0.45 power gradation chart.

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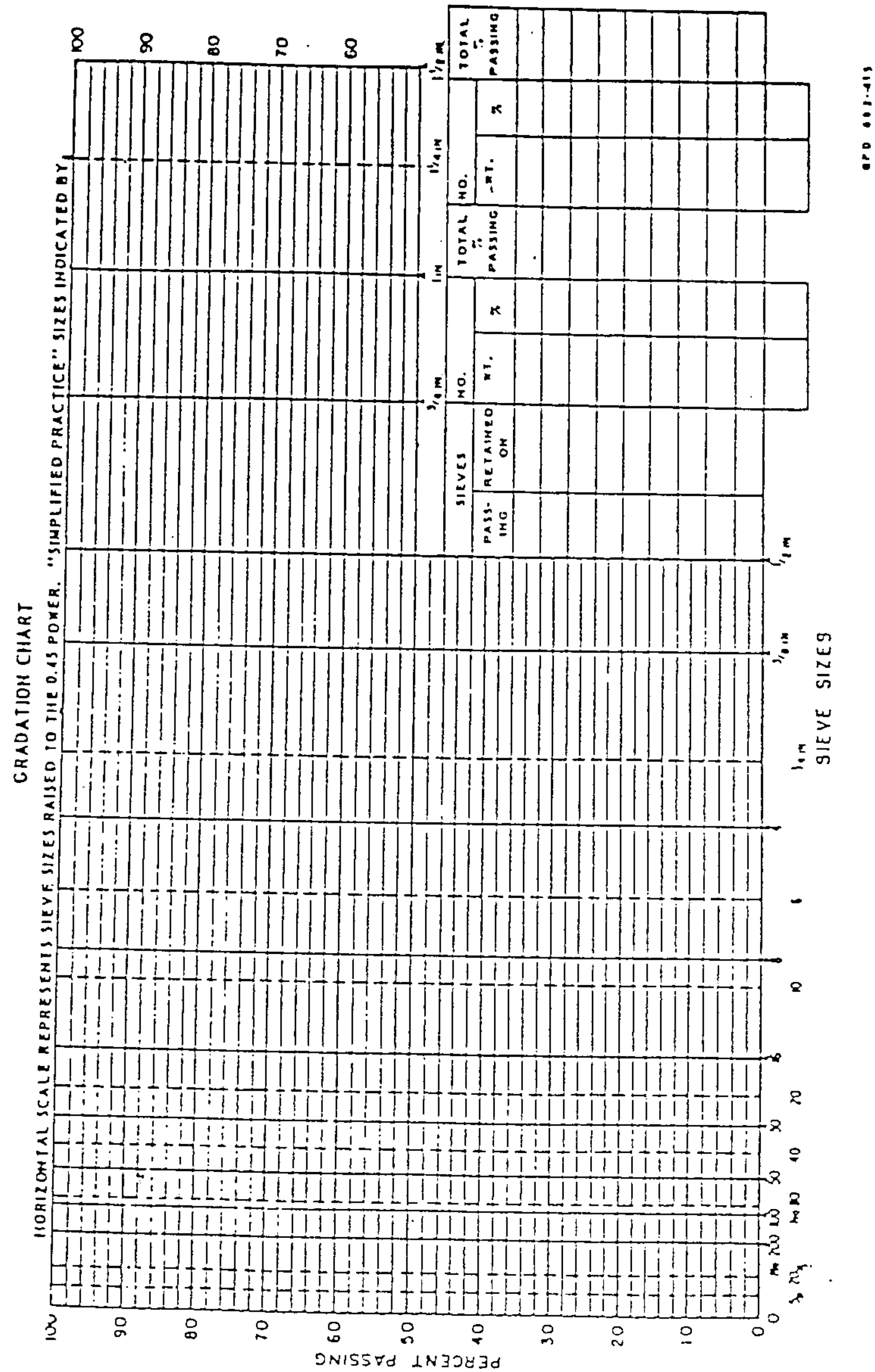

Figure #1

0.45 Power Gradation Chart

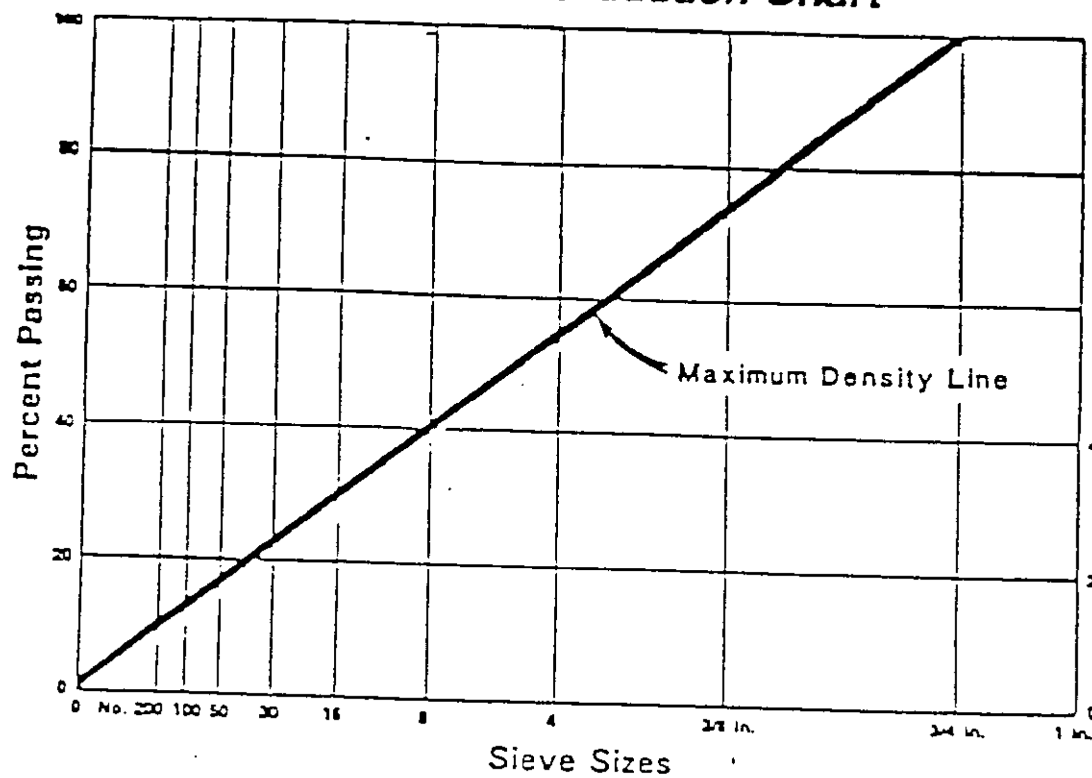

Figure #2

0.45 Power Gradation Chart

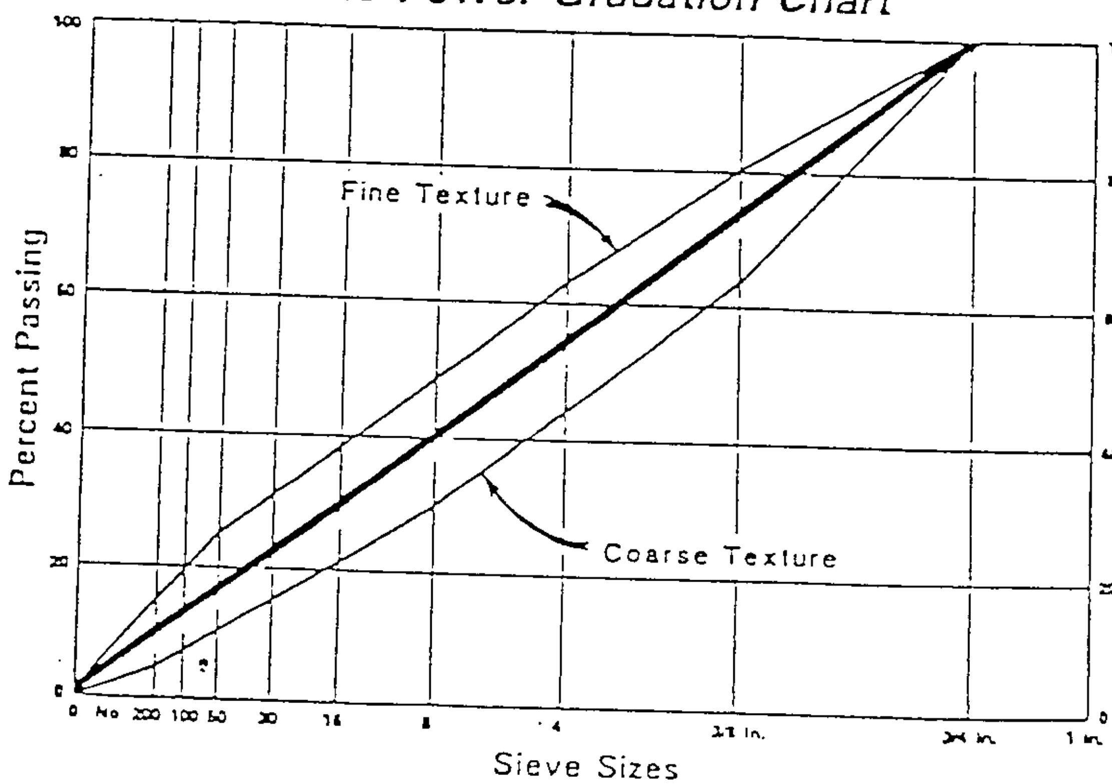

Figure #3

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0.45 Power Gradation Chart

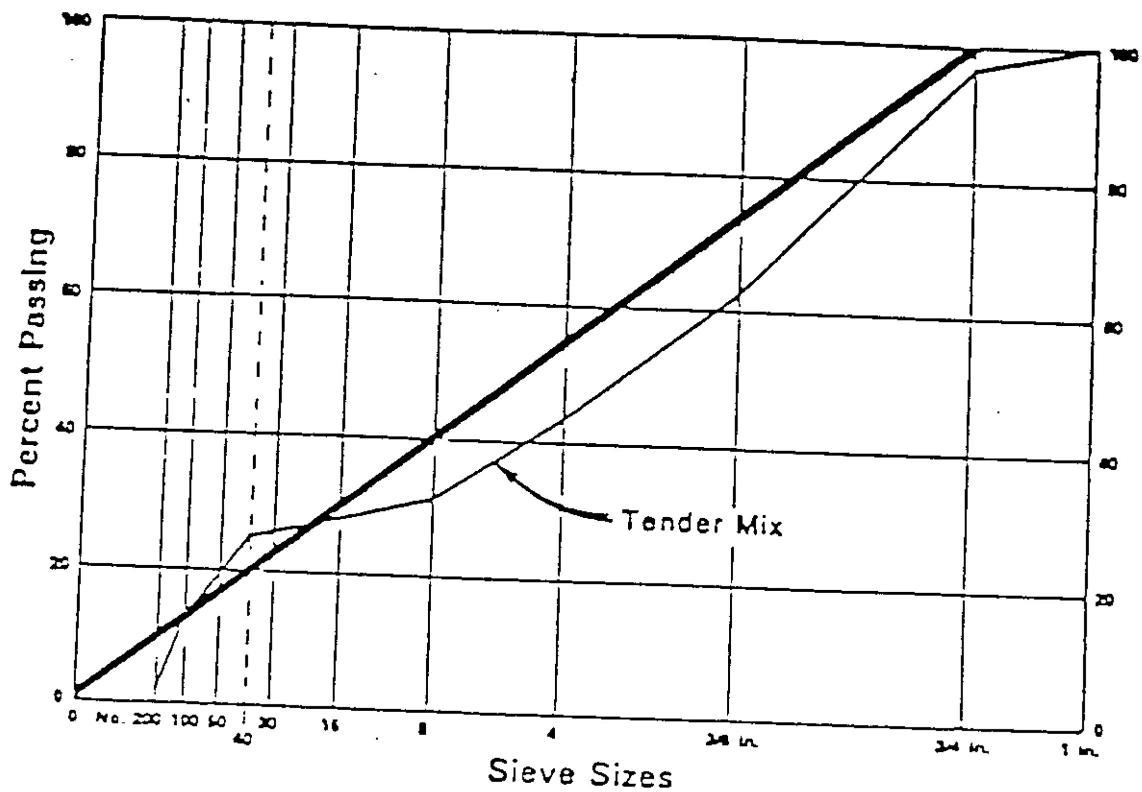


Figure #4

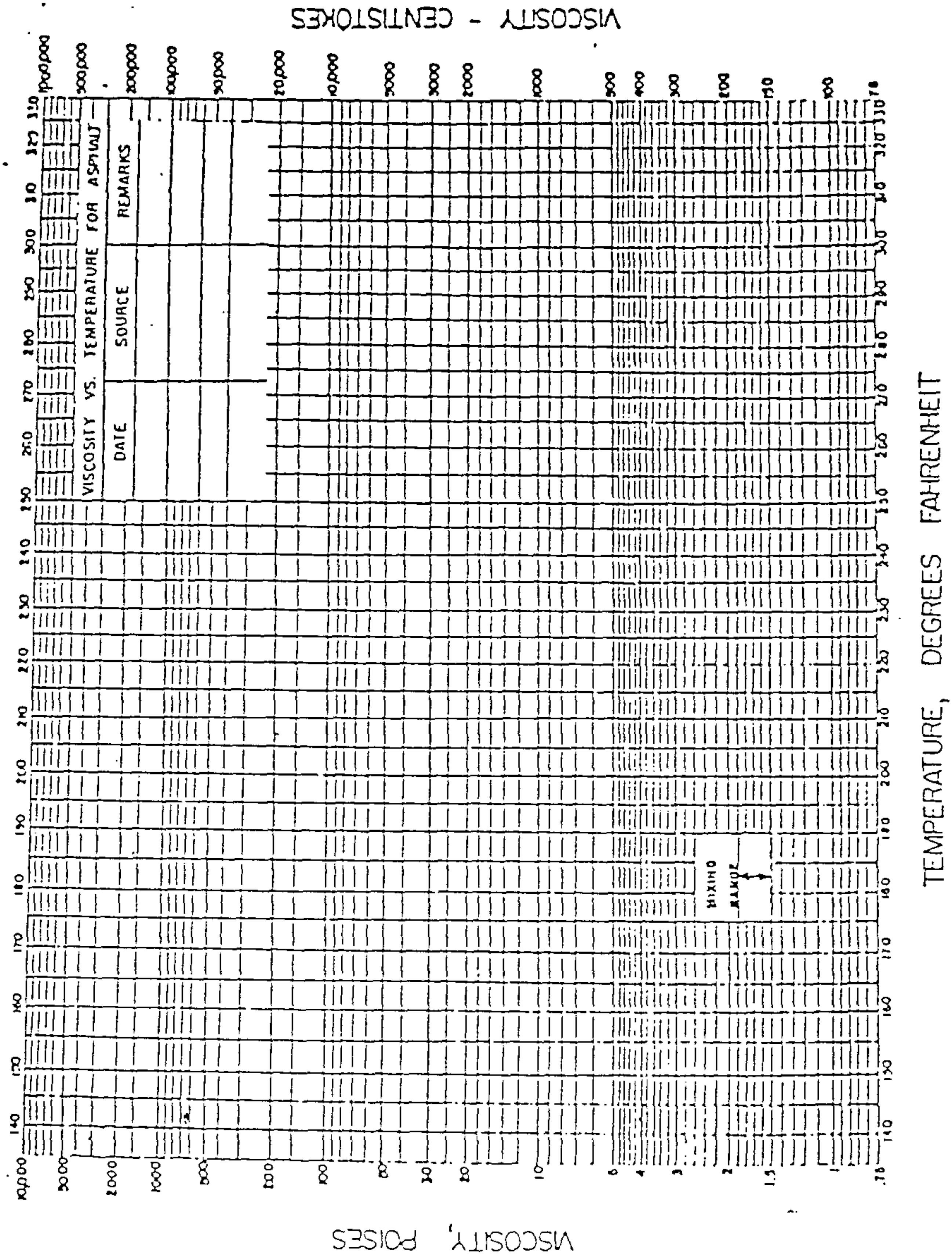
ASPHALT VISCOSITY

Each particular asphalt has a unique temperature-viscosity relationship. This relationship is sometimes described as temperature susceptibility. This temperature-viscosity relationship can be plotted on a modified semi-log chart as shown on the attached chart. These charts are very useful in determining the optimum mixing and compacting temperature of a particular asphalt. Past research has identified the optimum mixing temperature as that corresponding to a viscosity of 170 $\pm$ 20 centistokes, and the optimum compaction temperature as that corresponding to a viscosity of 280 $\pm$ 30 centistokes for laboratory mix design. The optimum mixing temperature should be identified for the asphalt used in the mix design and included in the mix design report which is sent to the production plant.

Prior to the oil embargo, there was a relatively fixed distribution system for crude oil. This allowed for a relatively uniform asphalt cement from each refinery. Highway agencies became familiar with the handling and performance characteristics of those asphalt cements. As a result of the embargo, a new variable distribution system is in place which allows shifting and blending of crude oils resulting in production of asphalt cements with very different temperature viscosity characteristics.

The attached chart will allow plotting the temperature-viscosity curve for the asphalts used in a State or a particular asphalt from a project. If the kinematic viscosity (275° F) of the asphalt being used changes from the kinematic viscosity of the asphalt used in the mix design by a factor of more than about two, a new mix design should be required.

FHWA TECHNICAL ADVISORY T 5040.27
March 10, 1988
ATTACHMENT 2



MODEL CHECK LIST FOR ASPHALT PLANT

COMPANY ______________________________

LOCATION ______________ INSPECTED BY ____________ DATE __________

TYPE PLANT AND MANUFACTURER NAME ______________________

MAXIMUM BATCH ______________ LBS.

RATED TONS PER HOUR ______________

PROJECT NO. ______________ COUNTY ______________

I. Stockpiles

1. Properly separated.
2. Material segregated.
3. Has contractor submitted and received approval of intended materials sources and job mix formula?
4. Is area clean and properly kept?

II. General Requires for all Plants

1. Are tanks for storage of asphalt cement equipped for heating the material under effective and positive control at all times?
2. Are tanks or storage material properly heated?
3. Is a circulating system for the asphalt cement of adequate capacity to provide proper and continuous circulation between storage tank and proportioning units during the entire operating period?
4. Is the discharge end of the asphalt cement circulating pipe kept below the surface of the material in the storage tank?
5. Are all pipe links and fittings steamed, oil jacketed, or otherwise properly insulated to prevent heat loss?
6. Is storage tank capacity such as to ensure continuous operation of the plant and uniform temperature of the asphalt cement when it is mixed with the aggregate?
7. Are tanks accurately calibrated to 100 gallons (378.5 L) and accessible for measuring the volume of the asphalt cement?
8. Is a sampling outlet provided in the asphalt feed lines?
9. Is a drainage receptacle provided for flushing the outlet prior to sampling?

III. Anti-Strip and Other Additive Systems

1. Is anti-strip material added at plant site?
2. If anti-strip material is added at plant site, does the anti-strip system meet specifications?
3. If other approved additives are used, are they handled in accordance with an established procedure?

IV. Cold Feed System

1. Number of cold bins. __________
2. Does plant have mechanical or electrical means for uniformly feeding the aggregates into the dryer?
3. Does cold feed have a synchronized proportioning method when blending aggregates from two or more bins?
4. If mineral filler is required, is a separate bin provided?
5. Is the feeder for mineral filler furnished with the feeder drive positively interlocked and synchronized with the aggregate feeds?

V. Drier

1. Number of driers. __________
2. Is a drier of satisfactory design provided?

VI. Dust Collectors and Emission Controls

1. What type dust collector is provided?
2. Can the material collected in the dust collector be wasted or any part or all of the material be returned to the aggregate mixture?
3. Does the plant meet applicable limitations on emissions?
4. Has company received a permit to operate from EPA?

VII. Thermometric Equipment

1. Is a recording pyrometer or armored thermometer located in the asphalt cement feed line near the discharge end at the mixer unit?
2. Is the plant equipped with recording pyrometers, or armored thermometers or other approved thermometric instruments at the discharge end of the drier?
3. Has accuracy of pyrometers or thermometers been checked?

VIII. Surge and Storage Bins

1. Is plant equipped with surge or storage bins?
2. What type bin? Surge or storage?
3. Is unit enclosed, insulated, weather proof?
4. Is unit equipped with material level indicator?
5. Is the indicator visible from plant operator or weigh master's station?
6. Does unit have approved thermometric instrument so placed to indicate automatically the temperature of mixture at discharge?

7. Is conveyer system covered and insulated (if necessary) so as to prevent excessive loss of heat during transfer of material from mixing plant to storage bin?
8. Does storage bin have acceptable heating system?
9. Has surge or storage bin received prior evaluation and approval before using?

IX. Safety and Inspection Provisions

1. Are gears, pulleys, chains, sprockets, and other dangerous moving parts thoroughly protected?
2. Is an unobstructed and adequately guarded passage provided and maintained in and around the truck loading space for visual inspection purposes?
3. Does plant have adequate and safe stairways or guarded ladders to plant units such as mixer platforms, control platforms, hot storage bins, asphalt storage tanks, etc. where inspections are required?
4. Is an inspection platform provided with a safe stairway for sampling the asphalt mixture from loaded trucks?

X. Truck Scales

1. Are scales capable of weighing the entire vehicle at one time?
2. Do scales have digital printing recorder or automatic weight printer?
3. Have scales been checked and certified by a reputable scale company in the presence of an authorized representative of the highway department?
4. Date checked ________________ Agency Name ________________________
5. Is copy of certification available?
6. Remarks ____
____
____
____
____

XI. Transportation Equipment

1. Are truck bodies clean, tight, and in good condition?
2. Do trucks have covers to protect material from unfavorable weather conditions?
3. Is soapy water or other approved products available for coating truck bodies to prevent material from sticking? Diesel fuel should not be used.
4. Type of material used. ________________

XII. Provisions for Testing

1. Does size and location of laboratory comply with specifications?
2. Is laboratory properly equipped?
3. Is laboratory acceptable?

SPECIAL REQUIREMENTS FOR BATCH PLANTS

XIII. Weigh Box or Hopper

1. Is weigh box large enough to hold full batch?
2. Does gate close tightly so that material cannot leak into the mixer while a batch is being weighed?

XIV. Aggregate Scales

1. Are scales equipped with adjustable pointers or markers for marking the weight of each material to be weighed into the batch?
2. Are ten 50-lb. (22.7 kg) weights available for checking scales?
3. Has accuracy of weights been checked?
4. Have scales been checked and certified by a reputable scales company in the presence of an authorized representative of the highway department?
   Date checked ________________ Agency Name ________________________
   Is copy of certification available?
   Remarks ____
   ____
   ____
   ____
   ____
   ____
5. If the plant is equipped with beam type scales, are the scales equipped with a device to indicate at least the last 200 lb. (97 kg) of the required load?

XV. Asphalt Cement Bucket

1. Is bucket large enough to handle a batch in a single weighing so that the asphalt material will not overflow, splash or spill?
2. Is the bucket steamed, or oil-jacketed or equipped with properly insulated electric heating units?
3. Is the bucket equipped to deliver the asphalt material over the full length of the mixer?

XVI. Asphalt Cement Scales

1. Have scales been checked and certified by a reputable scale company in the presence of an authorized representative of the highway department?
   Date checked ______________ Agency Name ______________________
   Is copy of certification available?
   Remarks ____

   ____

2. Are scales equipped with a device to indicate at least the last 20 lb. (9.1 kg) of the approaching total load?

XVII. Screens

1. Condition of screens. Satisfactory _______ Unsatisfactory _______
2. Do the plant screens have adequate capacity and size range to properly separate all the aggregate into sizes required for proportioning so that they may be recombined consistently?

XVIII. Hot Bins

1. Number of bins? ______________
2. Are bins properly partitioned?
3. Are bins equipped with overflow pipes?
4. Will gates cut off quickly and completely?
5. Can samples be obtained from bins?
6. Are bins equipped with device to indicate the position of aggregate at the lower quarter point?

XIX. Asphalt Control

1. Are means provided for checking the quantity or rate of flow of asphalt material?
2. Time required to add asphalt material into pugmill.

XX. Mixer Unit for Batch Method

1. Is the plant equipped with an approved twin pugmill batch mixer that will produce a uniform mixture?
2. Can the mixer blades be adjusted to ensure proper and efficient mixing?
3. Are the mixer blades in satisfactory condition?
4. What is the clearance of the mixer blades? ______________ in.
5. Does the mixer gate close tight enough to prevent leakage?
6. Does the mixer discharge the mixture without appreciable segregation?
7. Is the mixer equipped with time lock?
8. Does timer lock the weigh box gate until the mixing cycle is completed?

APPENDIX E

PRE-CONSTRUCTION MATERIAL SAMPLING AND TESTING PLAN

PAVEMENT CONSULTANCY SERVICES
A DIVISION OF LAW ENGINEERING

Tech Memo: TM-PCS-4 Date: March 29, 1990

Distribution: Dr. Amir Hanna, Guy Dore, Bill Hadley, Neil Hawks, RCOCs, SREs

Authors: John Miller

Subject: Material Sampling and Testing for SPS-5

This memorandum presents the final recommended materials sampling and laboratory testing plan for SPS-5 experiment sites. Decisions reached at the March 23, 1990 Advisory Committee meeting have been incorporated into the attached summary tables and figures. It must be understood that the plan presented here is applicable to an ideal site and would be modified according to local conditions to properly characterize the materials and account for within site variability.

To reiterate the reasoning behind selection of the test methods and frequency of sampling and testing in contrast to the SHRP General Pavement Studies (GPS), the SPS studies start with controlled construction of multiple test sections co-located on a project. On an SPS-5 project there are 8 experimental overlay test sections and one control section. Due to the greater investment in construction of experimental test sections the opportunity to collect a complete historical data record starting from construction and the greater yield of information due to multiple test sections on the same site, a more rigorous materials testing program on SPS projects than is currently used on GPS projects is justified.

The test plan will be incorporated into a set of guidelines for use by RCOC personnel in developing site-specific sampling and testing plans. Any additional comments should be forwarded as soon as possible so that the guidelines may be finalized.

12240 Indian Creek Court, S
Beltsville, Maryland 20705-12
Telephone (301) 604-5105
FAX (301) 604-5032

TABLE 1

SPS-5 LABORATORY TESTING PLANS (PRE-CONSTRUCTION)

Material Type and Properties	SHRP Designation	SHRP GPS Protocol	Tests/Samples per Layer	Material Source/ Test Locations
PRE-CONSTRUCTION				
I. ASPHALT CONCRETE				
A. ASPHALTIC CONCRETE:				
Core Examination/Thickness	AC01	P01	26	ALL CORES
Bulk Specific Gravity	AC02	P02	9	C2 [C3,C4] C13 [C14,C15] C22 [C23,C24][4]
Maximum Specific Gravity	AC03	P03	3	[BA1-3] [TP] [BA4-6]
Asphalt Content (Extraction)	AC04	P04	3	[BA1-3] [TP] [BA4-6]
Moisture Susceptibility	------	NOTE 1	3	A1 A2 A3
Creep Compliance	------	NOTE 2	3	C5 C9 C20
Resilient Modulus	AC07	P07	3	[C3,C4] [C14,C15] [C23,C24]
Tensile Strength	AC07	P07	3	C2 C13 C22
B. EXTRACTED AGGREGATE:				
Type and Classification:				
Coarse Aggregate	AG03		3	[BA1-3] [TP] [BA4-6]
Roundness Index of Coarse Aggregate	------	NOTE 3	3	[BA1-3] [TP] [BA4-6]
Fine Aggregate	AG03		3	[BA1-3] [TP] [BA4-6]
NAA Test for Fine Aggregate Particle Shape	AG05	P14A NOTE 3	3	[BA1-3] [TP] [BA4-6]
Gradation of Aggregate	AG04	P14	3	[BA1-3] [TP] [BA4-6]
C. ASPHALT CEMENT:				
Abson Recovery	AE01		3	[BA1-3] [TP] [BA4-6]
Penetration at 50F,77F,90F	AE02		3	[BA1-3] [TP] [BA4-6]
Specific Gravity (60F)	AE04		3	[BA1-3] [TP] [BA4-6]
Viscosity at 77F	------	ASTM D3205-86	3	[BA1-3] [TP] [BA4-6]
Viscosity at 140F,275F	AE06		3	[BA1-3] [TP] [BA4-6]

NOTES:
1. Moisture susceptibility will be assessed by visual means on cores split in the field.
2. Creep compliance will be performed when suitable procedures are developed -- cores will be stored.
3. National Aggregate Association will perform tests at no cost to the State.
4. Cores within brackets are from the same sampling location.

TABLE 1 cont'd

SPS-5 LABORATORY TESTING PLANS (PRE-CONSTRUCTION)

Material Type and Properties	SHRP Designation	SHRP GPS Protocol	Tests/Samples per Layer	Material Source/ Test Locations
II. BOUND (TREATED) BASE AND SUBBASE				
Type and Classification of Material and Treatment	TB01	P31	3	C3,C4 C14,C15 C23,C24
Pozzolanic/Cementitious: Compressive Strength	TB02	P32	3	C3,C4 C14,C15 C23,C24
Asphalt treated: Dynamic Modulus (77F)	TB03	P33	3	C3,C4 C14,C15 C23,C24
HMAC: Resilient Modulus	AC07	P07	3	C3,C4 C14,C15 C23,C24
III. UNBOUND GRANULAR BASE AND SUBBASE				
Particle Size Analysis	UG01	P41	3	[BA1-3] [TP] [BA4-6]
Sieve Analysis (washed)	UG02	P41	3	[BA1-3] [TP] [BA4-6]
Atterberg Limits	UG04	P43	3	[BA1-3] [TP] [BA4-6]
Moisture-Density Relations	UG05	P44	3	[BA1-3] [TP] [BA4-6]
Resilient Modulus	UG07	P46	3	[BA1-3] [TP] [BA4-6]
Classification	UG08	P47	3	[BA1-3] [TP] [BA4-6]
Permeability	UG09		3	[BA1-3] [TP] [BA4-6]
Natural Moisture Content	UG10	P49	3	[BA1-3] [TP] [BA4-6]
IV. SUBGRADE				
Sieve Analysis	SS01	P51	3	[BA1-3] [TP] [BA4-6]
Hydrometer to 0.001mm	SS02	P42	3	[BA1-3] [TP] [BA4-6]
Atterberg Limits	SS03	P43	3	[BA1-3] [TP] [BA4-6]
Classification	SS04	P52	3	[BA1-3] [TP] [BA4-6] A1 A2 A3
Moisture-Density Relations	SS05	P55	3	[BA1-3] [TP] [BA4-6]
Resilient Modulus	SS07	P46	3	[BA1-3] [TP] [BA4-6]
Unit Weight	SS08		3	[BA1-3] [TP] [BA4-6] A1 A2 A3
Natural Moisture Content	SS09	P49	3	[BA1-3] [TP] [BA4-6]
Depth to Rigid Layer			3	S1 S2 S3

TABLE 2

SPS-5 LABORATORY TESTING PLANS (POST-CONSTRUCTION)

Material Type and Properties	SHRP Designation	SHRP GPS Protocol	Tests/Samples per Layer	Material Source/ Test Locations
A. ASPHALTIC CONCRETE:				
Core Examination/Thickness	AC01	P01	32	ALL CORES
Bulk Specific Gravity	AC02	P02	32	ALL CORES
Maximum Specific Gravity	AC03	P03	6	FROM UNCOMPACTED MIX, 3 PER MIX
Asphalt Content (Extraction)	AC04	P04	6	FROM UNCOMPACTED MIX, 3 PER MIX
Moisture Susceptibility	AC05		6	FROM UNCOMPACTED MIX, 3 PER MIX
Creep Compliance	------	NOTE 1	6	C1 C5 C10 C17 C25 C29
Resilient Modulus	AC07	P07	3	C7,C8 C11,C12 C27,C28
Tensile Strength	AC07	P07	3	C6 C10 C26
B. EXTRACTED AGGREGATE:				
Bulk Specific Gravity:				
Coarse Aggregate	AG01		6	FROM UNCOMPACTED MIX, 3 PER MIX
Fine Aggregate	AG02		6	FROM UNCOMPACTED MIX, 3 PER MIX
Type and Classification:				
Coarse Aggregate	AG03		6	FROM UNCOMPACTED MIX, 3 PER MIX
Fine Aggregate	AG03		3	[BA1-3] [TP] [BA4-6]
Roundness Index of Coarse Aggregate	------		3	[BA1-3] [TP] [BA4-6]
NAA Test for Fine				
Aggregate Particle Shape	AG05	P14A NOTE 2	3	[BA1-3] [TP] [BA4-6]
Fine Aggregate	AG03		6	FROM UNCOMPACTED MIX, 3 PER MIX
Gradation of Aggregate	AG04	P14	6	FROM UNCOMPACTED MIX, 3 PER MIX
C. RAP Aggregate:				
Bulk Specific Gravity:				
Coarse Aggregate	AG01		3	PRIOR TO MIXING
Fine Aggregate	AG02		3	PRIOR TO MIXING
Type and Classification:				
Coarse Aggregate	AG03		3	PRIOR TO MIXING
Fine Aggregate	AG03		3	[BA1-3] [TP] [BA4-6]
Roundness Index of Coarse Aggregate	------		3	[BA1-3] [TP] [BA4-6]
NAA Test for Fine				
Aggregate Particle Shape	AG05	P14A NOTE 2	3	[BA1-3] [TP] [BA4-6]
Fine Aggregate	AG03		3	PRIOR TO MIXING
Gradation of Aggregate	AG04	P14	3	PRIOR TO MIXING
Asphalt Extraction	AC04	P04	3	PRIOR TO MIXING

NOTES:
1 Creep compliance will be performed when suitable procedures are developed -- cores will be stored.
2 National Aggregate Association will perform tests at no cost to the State.
- Cores within brackets are from the same sampling location.

TABLE 2 cont'd

SPS-5 LABORATORY TESTING PLANS (POST-CONSTRUCTION)

Material Type and Properties	SHRP Designation	SHRP GPS Protocol	Tests/Samples per Layer	Material Source/ Test Locations
POST-CONSTRUCTION				
D. ASPHALT CEMENT (FROM TANKER):				
Penetration at 50F,77F,90F	AE02		3	FROM PLANT
Specific Gravity (60F)	AE04		3	FROM PLANT
Viscosity at 77F		ASTM D3205-86	3	FROM PLANT
Viscosity at 140F,275F	AE06		3	FROM PLANT
E. ASPHALT CEMENT (FROM RAP):				
Abson Recovery	AE01		3	FROM PLANT
Penetration at 50F,77F,90F	AE02		3	FROM PLANT
Specific Gravity (60F)	AE04		3	FROM PLANT
Viscosity at 77F		ASTM D3205-86	3	FROM PLANT
Viscosity at 140F,275F	AE06		3	FROM PLANT
F. ASPHALT CEMENT (FROM VIRGIN MIX):				
Abson Recovery	AE01		3	FROM UNCOMPACTED MIX
Penetration at 50F,77F,90F	AE02		3	FROM UNCOMPACTED MIX
Specific Gravity (60F)	AE04		3	FROM UNCOMPACTED MIX
Viscosity at 77F		ASTM D3205-86	3	FROM UNCOMPACTED MIX
Viscosity at 140F,275F	AE06		3	FROM UNCOMPACTED MIX
G. ASPHALT CEMENT (FROM COMBINED MIX):				
Abson Recovery	AE01		3	FROM UNCOMPACTED MIX
Penetration at 50F,77F,90F	AE02		3	FROM UNCOMPACTED MIX
Specific Gravity (60F)	AE04		3	FROM UNCOMPACTED MIX
Viscosity at 77F		ASTM D3205-86	3	FROM UNCOMPACTED MIX
Viscosity at 140F,275F	AE06		3	FROM UNCOMPACTED MIX

Figure 1. SPS-5 SITE LAYOUT AND SAMPLING LOCATION (PRECONSTRUCTION)

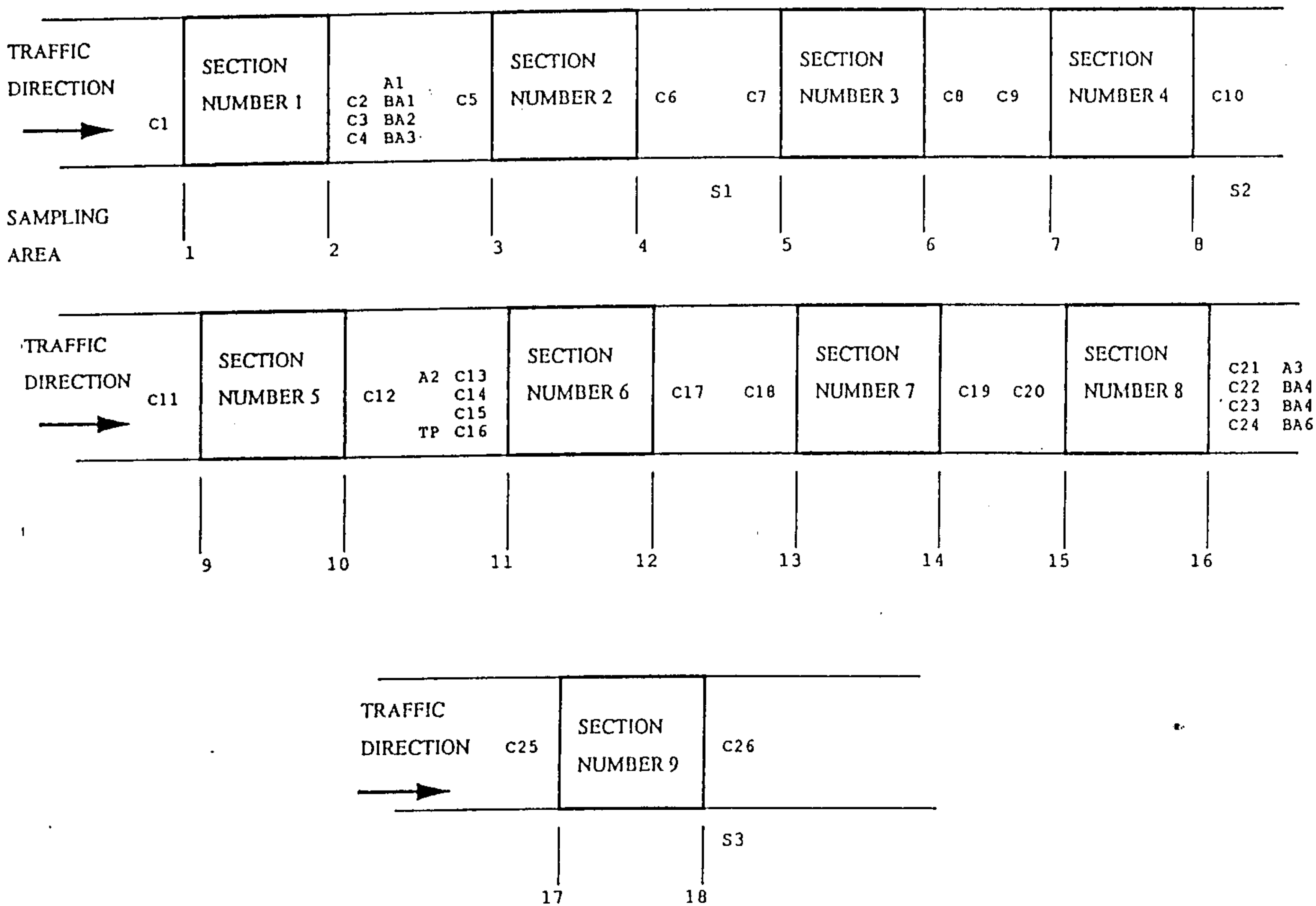
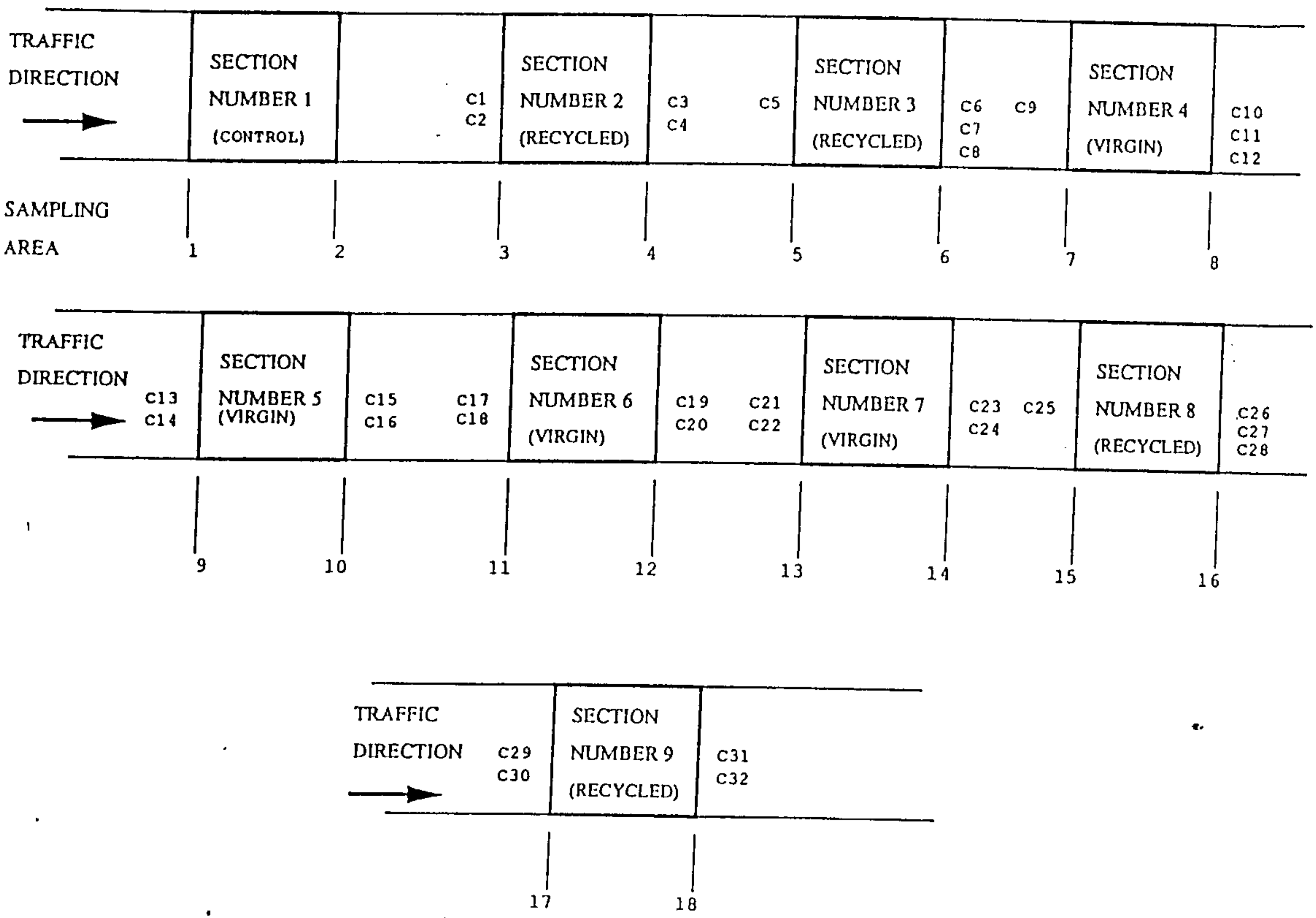


Figure 2. SPS-5 SITE LAYOUT AND SAMPLING LOCATION (POST CONSTRUCTION)



SHRP REGION : Western

STATE : Arizona

SHRP SECTION ID NUMBER : 040507(S1), 040504(S2), 040503(S3
040508(S4), 040509(S5), 040502(S6), 040501(S10)

EXPERIMENT NAME : (SPS-5)

HIGHWAY NUMBER : I 8

DATE OF FIELD MATERIAL
SAMPLING AND FIELD TESTING : 1 - 18 - 90

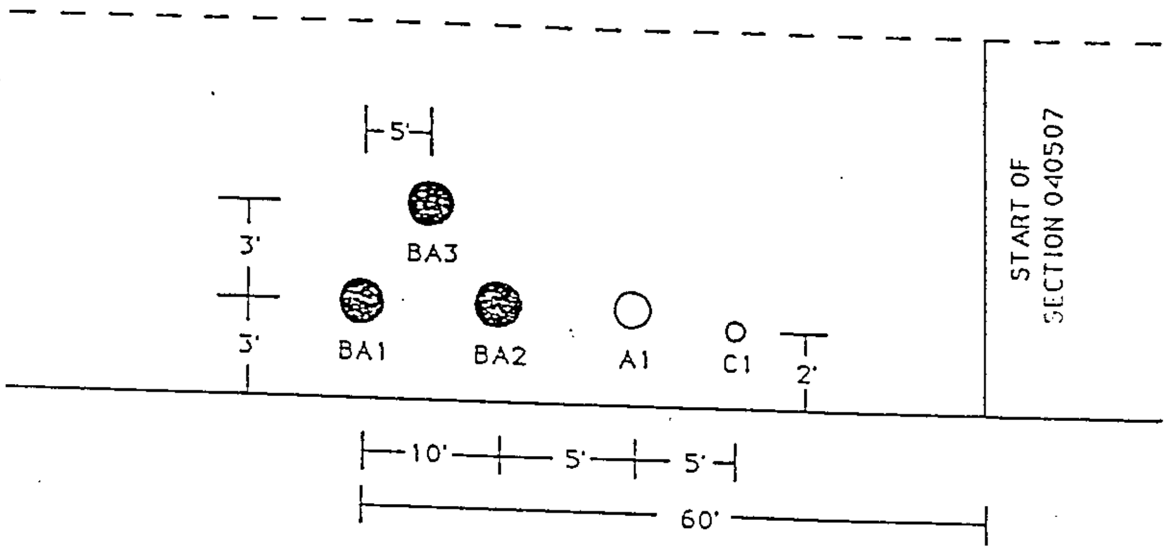
SUBMITTING CONTRACTOR : Chen-Northern, Inc.

TOTAL SHEETS, INCLUDING THIS COVER PAGE : 42 of 42

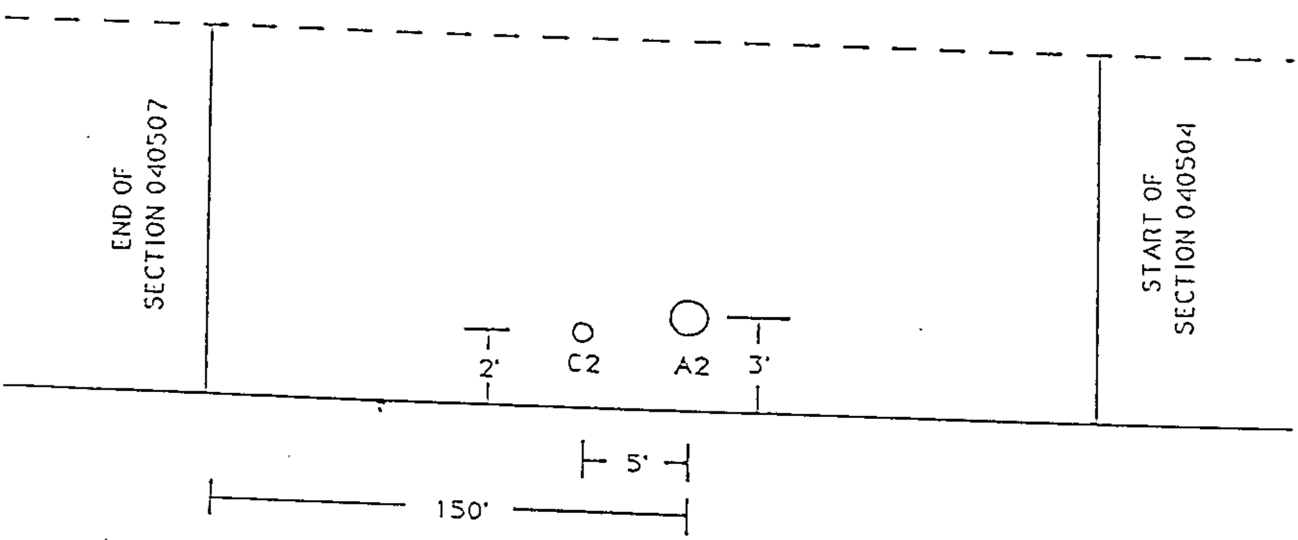
ISSUED 3 MARCH 1989

NOT TO SCALE

ARIZONA SPS-5



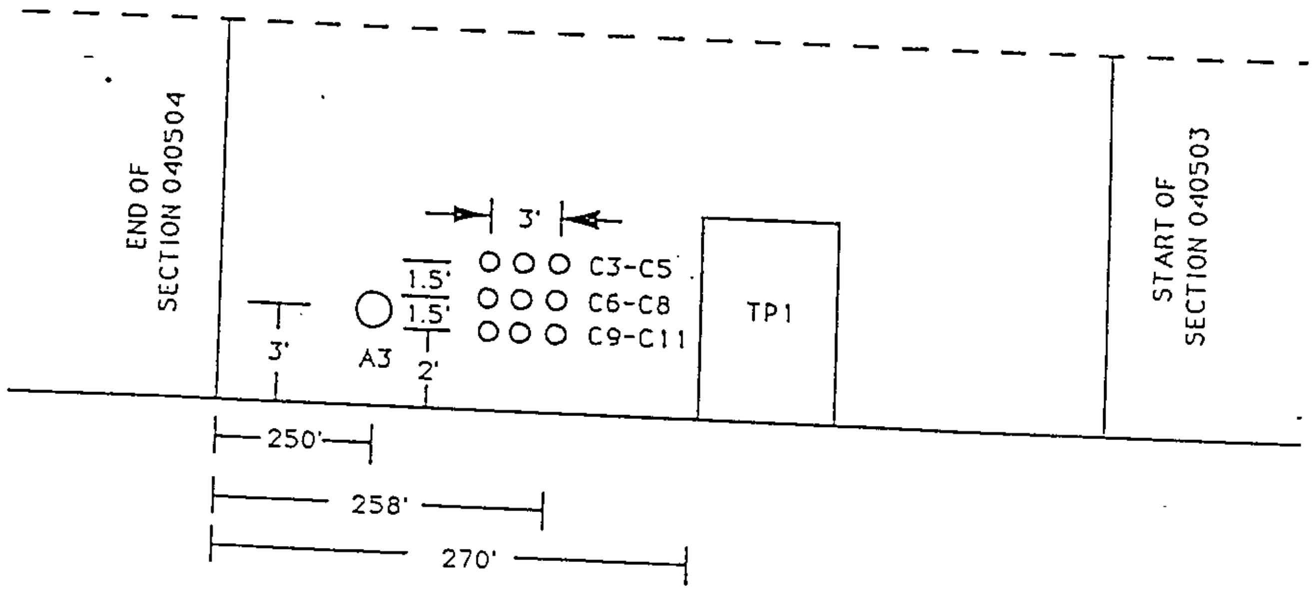
SAMPLE AREA S1



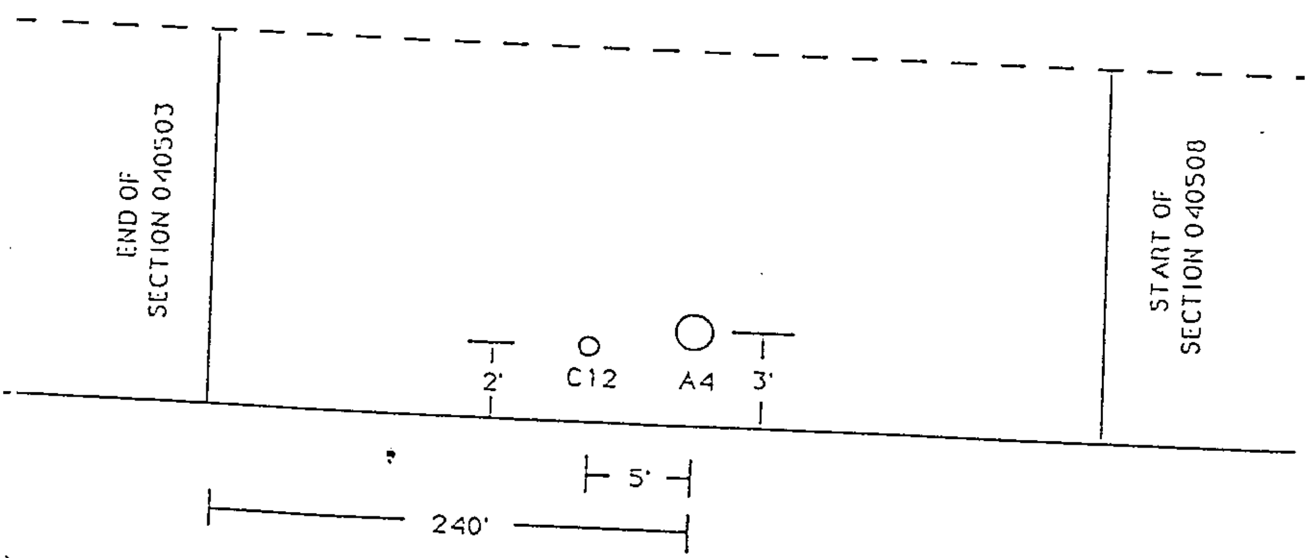
SAMPLE AREA S2

NOT TO SCALE

ARIZONA SPS-5



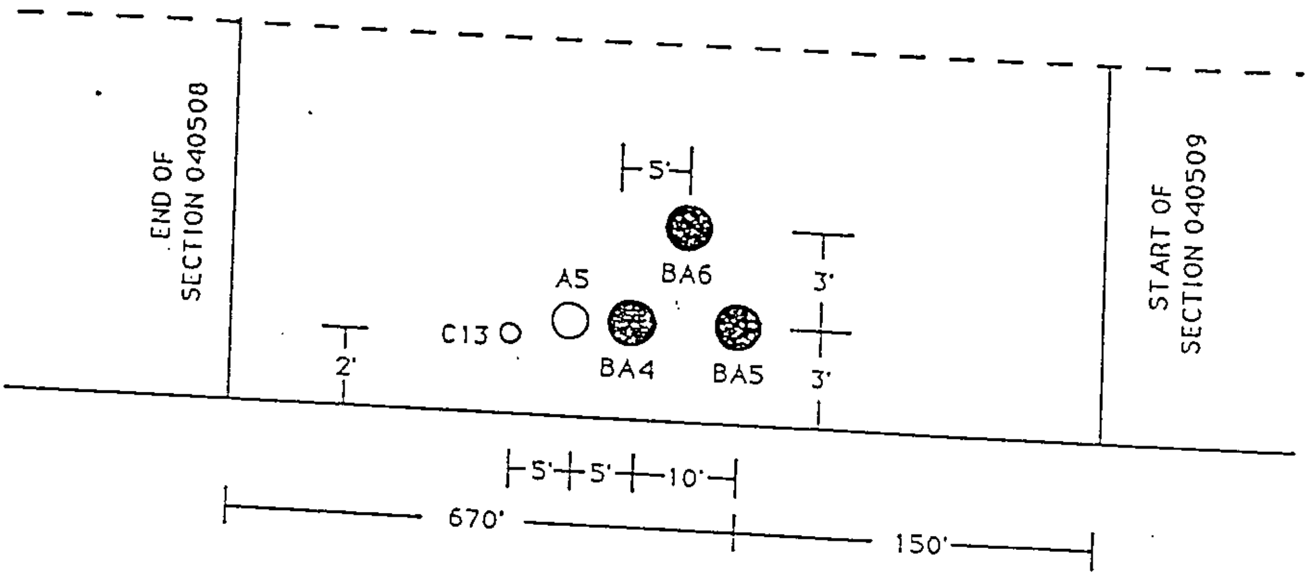
SAMPLE AREA S3



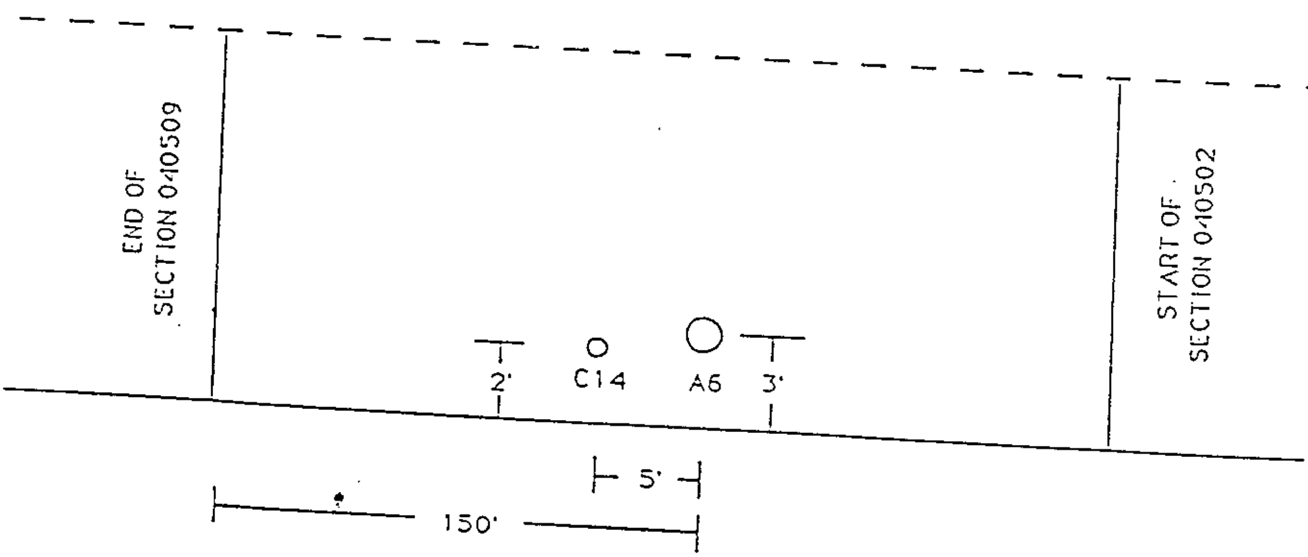
SAMPLE AREA S4

NOT TO SCALE

ARIZONA SPS-5



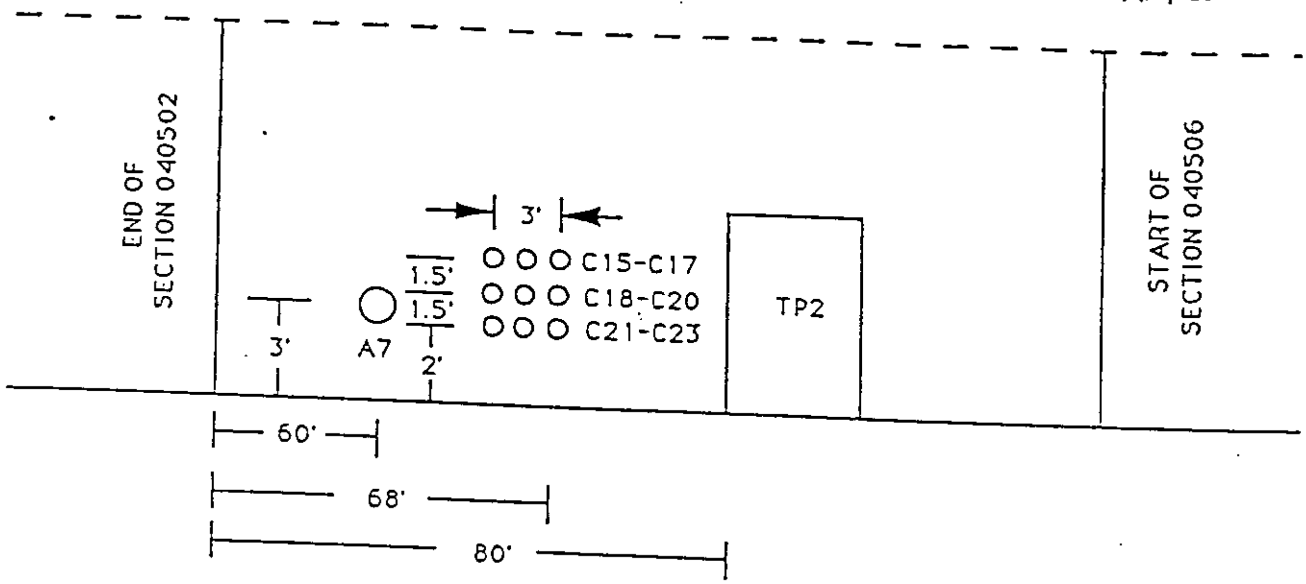
SAMPLE AREA S5



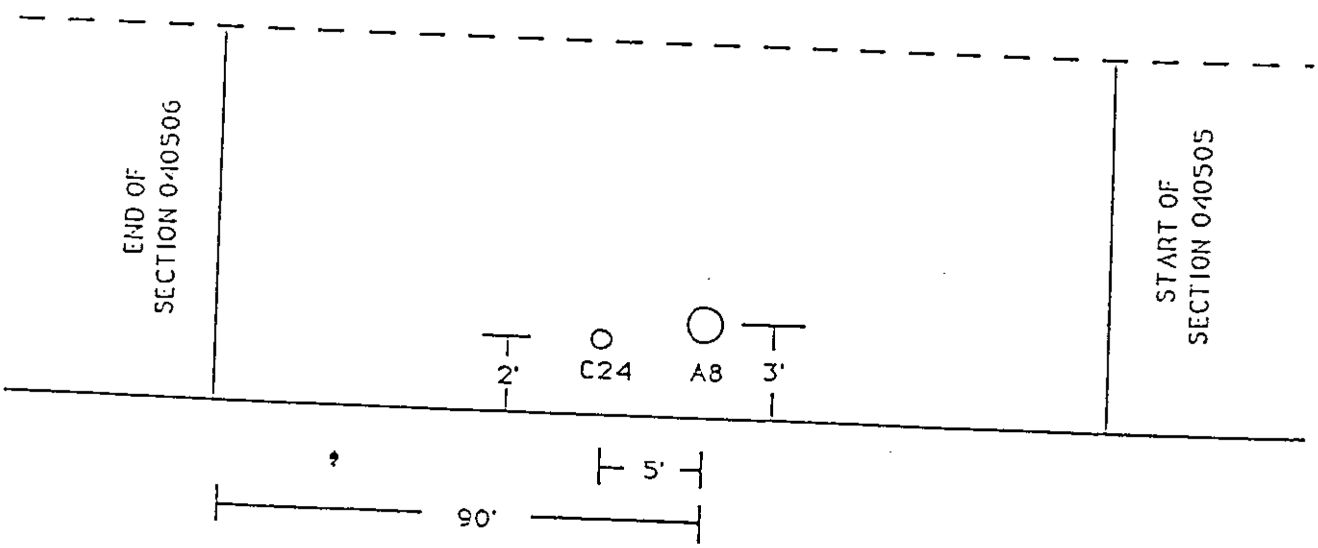
SAMPLE AREA S6

NOT TO SCALE

ARIZONA SPS-[illegible]



SAMPLE AREA S7

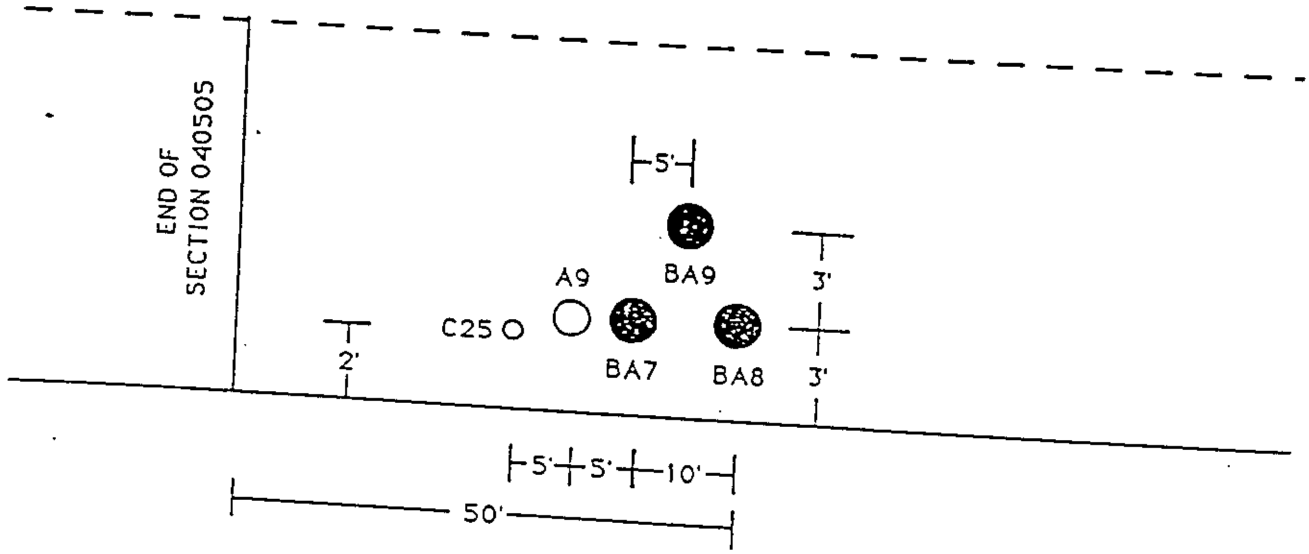


SAMPLE AREA S8

DRAFT

NOT TO SCALE

ARIZONA SPS-5

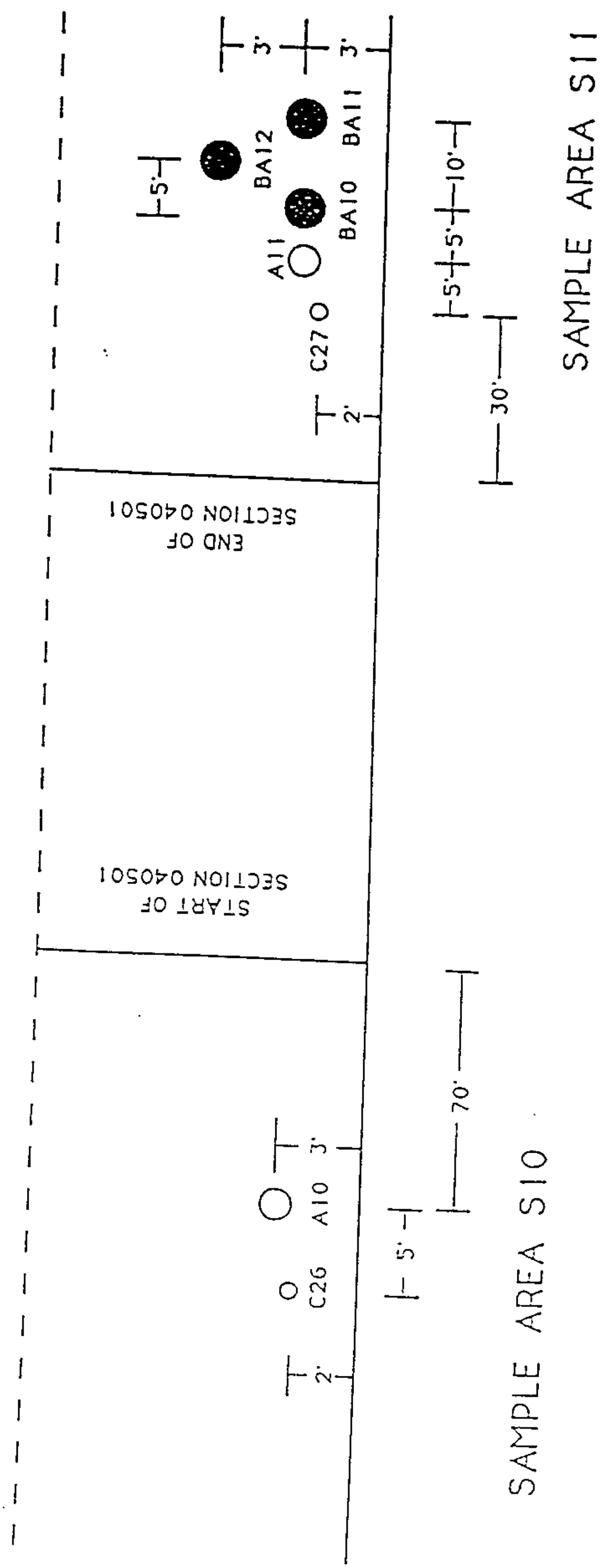


SAMPLE AREA S9

SAMPLING AREAS S10 AND S11, NEXT PAGE

ARIZONA - SPS -

NOT. TO SCALE



APPENDIX F

MIX DESIGNS FOR END-PRODUCT, RECYCLED AND ASPHALT RUBBER ASPHALT CONCRETE

CORN CONSTRUCTION CO.

New Mexico Contractor's License #28273

2701 Miles Road, S.E., Suite 175
Albuquerque, New Mexico 87106

(505) 764-9791

RECEIVED
APR 09 1990
ORG 4247
ARIZ DEPT OF TRANS
CASA GRANDE

April 4, 1990

Arizona Department of Transportation
Highway Division
Mr. Warren Goff
Resident Engineer
P.O. Box 983
Casa Grande, Arizona 85222

RE: Yuma - Casa Grande Highway (I-8)
(County Line - Stanfield Rd. T.I. EB)
ADOT Project Number IR-8-2(91)

Dear Mr. Goff:

Submitted herewith is our proposed Mix Design for Item 4160002 Asphaltic Concrete (3/4" Mix End Product) as prepared by Speedie and Associates. This design was prepared under the direct supervision of Donald L. Cornelison, P.E. of Speedie and Associates. All requested information is contained in their Mix Design report.

Your early review and approval will be appreciated.

Sincerely,

Marvin R. Appel
Vice President

SPEEDIE
AND ASSOCIATES
GEOTECHNICAL / MATERIALS / SITE ENGINEERS
11029 N. 24th AVE., SUITE 805 · PHOENIX, ARIZONA 85029 · (602) 997-6391

JAMES A. SPEEDIE, P.E.
GREGG A. CREASER, P.E.
GARY E. STOCKER, P.E.
STEVEN A. GRIESS, P.E.

March 30, 1990
Project No. 900072ZA

RECEIVED
APR 09 1990
ORG 4247
ARIZ DEPT OF TRANS
CASA GRANDE

Mr. Marv Appel
Corn Construction Company
2701 Miles Road SE, Suite No. 175
Albuquerque, New Mexico 87106

Re: Yuma - Casa Grande Highway (I-8)
(County Line - Stanfield Rd. T.I. EB)
ADOT Project Number IR-8-2(91)

Dear Marv,

As requested, we have completed an ADOT 3/4" asphalt concrete mix design for the above project.

The samples of aggregate used in the design were obtained from the Teepee Ready Mix pit which is located in Casa Grande, Arizona. The materials were designated as a M.A. Coarse aggregate, a M.A. Intermediate aggregate, a washed fine aggregate, and a crushed fine aggregate.

The asphalt cement used was grade AC-40 supplied by Chevron Asphalt Company and produced at their Richmond, CA Refinery. The mineral admixture used was Type II Portland Cement supplied by Arizona Portland Cement Company. It was added to the mix at a rate of 2.0% by weight of the mineral aggregate.

Complete Marshall, Immersion Compression, and aggregate test results are enclosed on the mix design report. All testing was performed in accordance with current ADOT procedures.

If you have any questions, please do not hesitate to call.

Respectfully submitted,

SPEEDIE & ASSOCIATES

Donald L. Cornelison

Donald L. Cornelison, P.E.
Laboratory Manager

CLIENT: CORN CONSTRUCTION

PROJECT: I-8 (COUNTY LINE TO STANFIELD RD.)

MIX DESIGNATION: ADOT 3/4"

SOURCE OF SAMPLES: STOCKPILES

LAB NO: 9000722A 0-072

DATE: 3/[illegible]

PROJECT NO: IR-8-2(91)

SOURCE OF MAT'L: TEE PEE READY MIX

SAMPLED BY: CLIENT

PERCENT MINERAL ADMIX: 2.0

COMPOSITE GRADATION

MATERIAL I.D.	% USED W/O ADMIX	% USED W/ADMIX
WASHED SAND	37	36.3
CRUSHED FINES	20	19.6
INTER AGG	13	12.7
COARSE AGG	30	29.4
ADMIX		2.0

SIEVE	W/O ADMIX % PASSING	W/ADMIX % PASSING	SPEC LIMITS
1-1/2"	100	100	100
1"	100	100	100
3/4"	100	100	90-100
1/2"	93	94	
3/8"	78	79	70-85
1/4"	63	64	
#4	58	58	
#8	46	47	41-52
#10	43	44	
#16	34	36	
#30	22	24	
#40	16	17	13-21
#50	11	12	
#100	5	7	
#200	2.9	4.8	3-6.5

AGGREGATE PROPERTIES

	COARSE	FINE	COMBINED	SPEC
BULK OD SP GR	2.573	2.569	2.571	2.35-2.85
SSD SP GR	2.602	2.599	2.600	
APPARENT SP GR	2.649	2.648	2.649	
ABSORPTION	1.106	1.174	1.145	0-2.50
SAND EQUIVALENT			67	45 min
PLASTICITY INDEX			NP	
CRUSHED FACES			63	30 min
L.A. ABRASION "B" * (HISTORICAL)				
100 REV. % LOSS			4	9 max
500 REV. % LOSS			17	40 max

DESIGN DATA

SPECIMEN	A	B	C	D	SP[illegible]
BIT. GRADE/SP GR	AC-40	1.026			
% OF BITUMEN	4.5	4.7	5.0	5.5	
BULK DENSITY (pcf)	142.0	142.5	143.2	144.6	
MARSHALL STABILITY (lb)	2828	3009	3281	3306	2000 *
FLOW	11	12	12	12	8-
% AIR VOIDS	6.7	6.1	5.2	3.6	5.8-[illegible]
% VMA	15.6	15.5	15.4	15.0	15.5-18.[illegible]
% AIR VOIDS FILLED	57.4	60.9	66.3	76.2	
% EFF ASP TOTAL MIX	4.04	4.25	4.55	5.05	

IMMERSION COMPRESSION

SAMPLE	AIR PSI	H2O PSI	RETENTION	% AC	% ADMIX
NO.1	622.2	462.6	74.3	4.7	2.0
NO.2					
NO.3					

****

RECOMMENDED BITUMEN CONTENT (%) = 4.7

****

DONALD L. CORNELISON

ARIZONA, U.S.A.

ADDITIONAL DATA

MAXIMUM DENSITY	151.7 PCF @ 4.7 %
ASPHALT ABSORPTION ON DRY AGG (%)	0.49
ASPHALT TYPE	AC-40
ASPHALT SOURCE	CHEVRON/RICHMOND
ADMIX TYPE	TYPE II PORTLAND CEMENT
ADMIX SOURCE	ARIZONA PORTLAND CEMENT

MARSHALL MIX DESIGN DATA
========================

CLIENT:	CORN CONSTRUCTION	DATE:	3/16/90
PROJECT:	I-8 (COUNTY LINE TO STANFIELD RD.)	PROJECT NO:	IR-8-2(91)
MIX DESIGNATION:	ADOT 3/4"	SOURCE OF MAT'L:	TEE PEE READY MIX
SOURCE OF SAMPLES:	STOCKPILES	SAMPLED BY:	CLIENT
LAB NO:	9000722A 0-072	PERCENT MINERAL ADMIX:	2.0

%AC	ADMIX	SPEC #	SSD WEIGHT	H2O WEIGHT	AIR WEIGHT	SPECIFIC GRAVITY	UNIT WEIGHT	HEIGHT	DIAL READING	STABILITY	FACTOR	CORRECTE STABILIT
		1	1170.8	658.3	1170.3	2.284	142.3	2.535	432	3186	0.98	312
4.50	2.0%	2	1177.8	661.4	1176.4	2.278	141.9	2.555	360	2661	0.96	255
		3	1171.3	656.8	1170.2	2.274	141.7	2.540	392	2894	0.97	280
		AVG				2.279	142.0					282
		1	1178.9	665.3	1178.3	2.294	142.9	2.528	415	3062	0.98	300
5.00	2.0%	2	1182.1	669.7	1181.7	2.306	143.7	2.530	496	3652	0.98	357
		3	1179.2	665.5	1178.9	2.295	143.0	2.524	452	3331	0.98	326
		AVG				2.298	143.2					328
		1	1183.8	673.7	1183.5	2.320	144.5	2.500	468	3448	1.00	344
5.50	2.0%	2	1182.5	671.8	1182.4	2.315	144.2	2.508	440	3244	0.99	321
		3	1181.7	674.1	1181.4	2.327	145.0	2.495	442	3258	1.00	325
		AVG				2.321	144.6					330

EFFECT OF WATER ON COHESION OF BITUMINOUS MIXTURES

CLIENT: CORN CONSTRUCTION

PROJECT: I-8 (COUNTY LINE TO STANFIELD RD.)

MIX DESIGNATION: ADOT 3/4"

SOURCE OF SAMPLES: STOCKPILES

LAB NO: 900072IA 0-072

DATE: 3/16/90

PROJECT NO: IR-8-2(91)

SOURCE OF MAT'L: TEE PEE READY MIX

SAMPLED BY: CLIENT

PERCENT MINERAL ADMIX: 2.0

PERCENT ASPHALT: 4.7

SPEC #	HEIGHT	SSD WT	H2O WT	AIR WT	SP GR	DENSITY	AVG SP GR	AVG DENSITY
1	4.068	1813.6	994.4	1809.5	2.209	137.6		
2	4.031	1813.5	996.4	1808.2	2.213	137.9		
3	4.036	1814.0	996.1	1809.9	2.213	137.9		
4	4.016	1813.9	995.6	1810.9	2.213	137.9	2.212	137.8
5	4.025	1814.5	995.2	1811.7	2.211	137.8		
6	4.003	1809.6	992.3	1806.3	2.210	137.7		

DESIGN DENSITY OF STABILITY SPECIMENS = 142.5

OF LAB DENSITY = IMC DENSITY/STAB DENSITY x 100 = 137.8/142.5 x 100 = 96.7

LOAD = 2750 PSI

COMPRESSIVE STRENGTH OF DRY SPECIMENS:

SPEC #	LOAD FAIL POINT	AVG LOAD FAIL PT	PSI
1	7485		
3	7681		
5	8299	7822	622.2

COMPRESSIVE STRENGTH OF WET SPECIMENS:

SPEC #	LOAD FAIL POINT	AVG LOAD FAIL PT	PSI
2	5565		
4	6314		
6	5565	5815	462.6

INDEX OF RETAINED STRENGTH = PSI(WET)/PSI(DRY) x 100 = 462.6/622.2 x 100 = 74.3

COMPOSITE GRADATION
=================

.NT: CORN CONSTRUCTION

PROJECT: I-8 (COUNTY LINE TO STANFIELD RD.)

MIX DESIGNATION: ADOT 3/4"

SOURCE OF SAMPLES: STOCKPILES

LAB NO: 900072ZA 0-072

DATE: 3/16/90

PROJECT NO: IR-8-2(91)

SOURCE OF MAT'L: TEE PEE READY MIX

SAMPLED BY: CLIENT

PERCENT MINERAL ADMIX: 2.0

	ORIGINAL GRADATION-% PASSING			
	MAT'L 1	MAT'L 2	MAT'L 3	MAT'L 4
MAT'L NAME	WASHED SAND	CRUSHED FINES	INTER AGG	COARSE AGG
% USED	37	20	13	30
SIEVE				
1-1/2"	100.0	100.0	100.0	100.0
1"	100.0	100.0	100.0	100.0
3/4"	100.0	100.0	100.0	100.0
1/2"	100.0	100.0	100.0	77.9
3/8"	100.0	100.0	95.6	30.0
1/4"	97.4	98.3	46.3	4.1
#4	93.7	97.3	21.9	2.1
[illegible]	78.7	78.5	4.5	1.4
#10	75.0	71.7	3.8	1.3
#16	62.3	53.4	2.8	1.2
#30	38.8	36.6	2.4	1.1
#40	24.8	30.1	2.2	1.0
#50	14.1	24.1	2.0	0.9
#100	3.4	15.2	1.6	0.8
#200	1.7	9.6	1.2	0.7

COMPOSITE % PASS (w/o ADMIX)	COMPOSITE % PASS (w/ADMIX)	GRADATION SPECS	SIEVE
100	100	100	1-1/2"
100	100	100	1"
100	100	90-100	3/4"
93	94		1/2"
78	79	70-85	3/8"
63	64		1/4"
58	58		#4
46	47	41-52	#8
43	44		#10
34	36		#16
22	24		#30
16	17	13-21	#40
11	12		#50
5	7		#100
2.9	4.8	3-6.5	#200

ADDITIONAL TEST DATA
===================

CLIENT: CORN CONSTRUCTION

PROJECT: I-8 (COUNTY LINE TO STANFIELD RD.)

MIX DESIGNATION: ADOT 3/4"

SOURCE OF SAMPLES: STOCKPILES

LAB NO: 9000722A 0-072

DATE: 3/16/90

PROJECT NO: IR-8-2(91)

SOURCE OF MAT'L: TEE PEE READY MIX

SAMPLED BY: CLIENT

PERCENT MINERAL ADMIX: 2.0

AGGREGATE SPECIFIC GRAVITIES

MAT'L	COARSE AGGREGATE	FINE AGGREGATE
S.S.D. WT.	4002.6	500.0
O.D. WT.	3958.8	494.2
IMMERSED WT.	2464.3	969.5
FLASK & H2O	-	661.9
BULK O.D. SP. GR.	2.573	2.569
S.S.D. SP. GR.	2.602	2.599
APPARENT SP. GR.	2.649	2.648
% ABSORPTION	1.106	1.174

RICE TEST

	SAMPLE WT. (DRY)	FLASK + H2O	SAMPLE + FLASK + H2O	SAMPLE WT (S.S.D.)	SAMPLE VOLUME	MAXIMUM SP. GR.	MAXIMUM DENSITY
1	1060.6	3677.9	4295.3	1061.8	444.4	2.387	148.7
2	1059.9	3662.1	4277.7	1061.4	445.8	2.378	148.1
3	1061.4	3700.2	4317.1	1062.1	445.2	2.384	148.5
AVG						2.383	148.4

SAND EQUIVALENT

	# 1	# 2	# 3	AVG.
SAND	4.3	4.0	4.1	
CLAY	6.3	6.3	6.1	
S.E.	69	64	68	67

CRUSHED FACES

TOTAL SAMPLE WT.	WT. CRUSHED	% CRUSHED FACES
300.0	188.8	62.9

MIX DESIGN VOID CALCULATIONS

CLIENT: CORN CONSTRUCTION

DATE: 3/16/90

PROJECT: I-8 (COUNTY LINE TO STANFIELD RD.)

PROJECT NO: IR-8-2(91)

MIX DESIGNATION: ADOT 3/4"

SOURCE OF MAT'L: TEE PEE READY MIX

SOURCE OF SAMPLES: STOCKPILES

SAMPLED BY: CLIENT

LAB NO: 900072ZA 0-072

PERCENT MINERAL ADMIX 2.0

SPECIFIC GRAVITY DATA

	COARSE AGG	FINE AGG	COMBINED AGG
BULK OD	2.573	2.569	2.571
SSD	2.602	2.599	2.600
APPARENT	2.649	2.648	2.649
ABSORPTION	1.106	1.174	1.145

RICE TEST DATA

MAX SP GR	MTD	%AC	ASPHALT SP GR	EFFECTIVE SP GR	ASPHALT ABSORPTION	ADMIX SP GR
2.383	148.4	6.0	1.026	2.602	0.486	3.14

VOID CALCULATIONS

%AC	SP GR	UNIT WT	% AGG	% ADMIX	TOTAL % ADMIX	AGG VOLUME	ADMIX VOLUME	EFFECTIVE ASPHALT	ASPHALT VOLUME	VMA	EFFECTIVE VOIDS	VOIDS FILLED
4.5	2.279	142.0	93.627	2.0	1.873	82.993	1.359	4.045	8.983	15.649	6.666	57.402
4.7	2.287	142.5	93.431	2.0	1.869	83.106	1.361	4.246	9.462	15.533	6.072	60.913
5.0	2.298	143.2	93.137	2.0	1.863	83.274	1.364	4.547	10.186	15.362	5.176	66.305
5.5	2.321	144.6	92.647	2.0	1.853	83.646	1.370	5.049	11.422	14.984	3.562	76.230

ARIZONA DEPARTMENT OF TRANSPORTATION

OFFICE MEMO

BITUMINOUS MIX DESIGN REPORT AND TRANSMITTAL

04/16/90

RECEIVED
APR 23 1990
ORG 4247
ARIZ DEPT OF TRANS
CASA GRANDE

To: Warren Goff
Transportation Engineer Team Leader
District Two (Casa Grande)

From: Don Corum
Materials Testing Engineer
Materials Section

Project No. IR 8-2(91) TRACS No. H001304C

Contractor Corn Construction Co.

Mix Design Originating Lab ADOT Central Lab

Originating Lab Mix Design Date 04/16/90

Mix Design Type:

____ 3/4" AC (VERIFICATION - SPEC. 406)

____ 1/2" AC (VERIFICATION - SPEC. 406)

____ MAG 3/4" AC (VERIFICATION - SPEC. ACPHX 406)

____ MAG 1/2" AC (VERIFICATION - SPEC. ACPHX 406)

XX RECYCLED AC (SPEC. 408)

____ A.C.F.C. (SPEC. 407)

____ OTHER: ________

Attached is a copy of our test results identified as Lab No. 90-7162E. This mix design is XX Acceptable ____ Unacceptable.

Project Notified of Results: Date - 04/12/90

Remarks: See attached sheet for contractors proposed four stockpile gradation specification bands.

Don Corum

cc: Joe Guerrini
Bill Beck
Construction File

MATERIALS SECTION
RECYCLED ASPHALTIC CONCRETE MIX DESIGN

PROJECT NUMBER: IR-8-2(91)   CONTRACTOR: CORN CONSTR.   MIX TYPE: RECYCLE
ORIGINATING LAB: ADOT CENTRAL   DESIGN LAB NO: 90-7162E   DATE: 04/11/90

AGG. #	1	2	3	4	5	6
TYPE	COARSE	INTER.	W-SAND	MAFINE	SALVAGED	
SOURCE	CM0253	CM0253	CM0253	CM0253	PAVEMENT	
% USE	29.0	7.0	30.0	4.0	30	

	TYPE	SOURCE	PERCENT	SP. GR.
ASPHALT CEMENT:	AC-20	CHEVRON (EL PASO)	3.5	0.996
ADMIXTURE:	TYPE II	ARIZ. PORTLAND	1.00	3.14

GRADATION (% PASSING -- PRODUCTION TARGETS ARE UNDERLINED)

SIEVE SIZE	VIRGIN AGGREGATE	EXTRACTED SALV. PAVE.	ANTICIPATED MIX TARGET W/O AD.	ANTICIPATED MIX TARGET W/ AD.
1.5 IN.	100	100	100	100
1 IN.	100	100	100	100
3/4 IN.	100	100	100	100
1/2 IN.	91	94	92	92
3/8 IN.	78	86	80	80
1/4 IN.	60	74	64	64
#4	53	65	57	57
#8	43	53	46	47
#10	40	50	43	44
#16	34	42	36	37
#30	23	33	26	27
#40	16	26	19	20
#50	10	19	13	14
#100	4	11	6	7
#200	1.9	7.6	3.6	4.6

AGGREGATE PROPERTIES: % ABRASION AT 100 REV. 4 500 REV. 20
SAND EQUIVALENT 71   % CRUSHED FACES 79

MIX PROPERTIES TESTED	TEST RESULT	SPECIFICATION REQUIREMENTS
STABILITY	3469	2000
FLOW	10	8 - 16
AIR VOIDS	5.4	5.0- 7.0
RETAINED STRENGTH	90.8	50
WET STRENGTH	366	150

OTHER MIX PROPERTIES:

MAXIMUM DENSITY 149.7 #/FT^3 AT 3.5 % ASPH.
BULK DENSITY 141.7 #/FT^3
FILM THICKNESS 7 MICRONS

REMARKS ON DESIGN
THIS DESIGN REQUIRES THE MINERAL AGGREGATE BE PUG-MILL MIXED WITH THE REQUIRED CEMENT IN THE PRESENCE OF 3 TO 5% MOIST. BY WEIGHT OF THE AGGREGATE.

APPROVED BY
Don Corum

TEST RESULTS FOR RECYCLE MIX DESIGN, LAB # 90-7162E, PROJECT NUMBER: IR-8-2(91)

AGGREGATE SAMPLES:

LAB #	TYPE	FROM	DATE	SOURCE	1"	3/4"	1/2"	3/8"	1/4"	#4	#8	#40	#200
90-158	COARSE	STOCKPILE	04/02/90	CM0253	100.0	100.0	78.0	47.0	17.0	11.0	6.0	4.0	1.70
90-157	INTER.	STOCKPILE	04/02/90	CM0253	100.0	100.0	100.0	97.0	46.0	17.0	1.0	1.0	1.00
90-156	W-SAND	STOCKPILE	04/02/90	CM0253	100.0	100.0	100.0	100.0	93.0	96.0	83.0	29.0	1.40
90-155	MAFINE	STOCKPILE	04/02/90	CM0253	100.0	100.0	100.0	100.0	99.0	98.0	84.0	40.0	7.60

AGGREGATE SOURCES:
SOURCE NO: CM0253 DESCRIPTION: T.P.#1.

MARSHALL TESTS:

TEST #	METHOD	DATE	% ASPHALT	%ADMIX	BULK DENSITY	STABILITY	FLOW	VOIDS	USED IN DESIGN?
1	MECH	04/07/90	3.0	1.0	140.7	3511	9	6.7	YES
2	MECH	04/07/90	3.5	1.0	141.7	3469	10	5.4	YES
3	MECH	04/07/90	4.0	1.0	143.5	3413	10	3.5	YES

RICE TESTS: (WITHOUT ADMIXTURE)

TEST #	DATE	% ASPHALT	MAXIMUM DENSITY	EFFECTIVE SP. GR.	USED IN DESIGN?
1	04/07/90	3.8	148.6	2.525	YES
2	04/07/90	4.3	147.7	2.527	YES

IMMERSION COMPRESSION TESTS:

TEST #	DATE	% ASPHALT	LOAD	MARSH. DENSITY	% OF MARSH. DENSITY	DRY STR.	WET STR.	RETAINED STR. %	USED IN DESIGN?
1	04/10/90	3.5	2000	141.7	97.0	403	366	90.8	YES

EXTRACTION CARD RESULTS:

LAB NO.	DATE	3/4"	3/8"	#4	#8	#40	#200	% ASPH
90-7163	09/05/89	99.5	82.0	62.3	47.6	22.8	5.71	5.50
90-7164	09/05/89	99.5	82.2	62.0	48.2	22.0	5.55	5.50

April 16, 1990

IR 8-2(91)
H 0013 04C

ASPHALTIC CONCRETE RECYCLE MIX DESIGN

The following information shows the average of (17) project stockpile gradation acceptance samples and the contractor's proposed stockpile gradation specification bands:

COARSE AGGREGATE / INTERMEDIATE AGGREGATE — PERCENT PASSING

	Coarse Aggregate		Intermediate Aggregate	
1"	100	100		
3/4"	100	(75-100)		
1/2"	69		100	100
3/8"	33	(23-43)	100	(80-100)
1/4"	6		68	(30-80)
#4	3		35	
#8	2		9	(0-20)
#40	1		4	
#200	0.9	(0-2)	1.6	(0-3)

CRUSHER FINES / WASHED SAND — PERCENT PASSING

	Crusher Fines		Washed Sand	
3/8	100	100	100	100
1/4	99	(90-100)	99	(90-100)
#4	97		96	
#8	73	(55-85)	84	(65-85)
#40	22	(10-38)	29	(11-31)
#200	6.9	(5-11)	1.6	(0-4)

MATERIALS SECTION
ASPHALTIC CONCRETE (MODIFIED) (ASPHALT RUBBER) DESIGN

PROJECT NUMBER: IR 8-2(91) CONTRACTOR: CORN CONSTRUCTION.
DEVELOPED BY: ADOT CENTRAL LAB DESIGN NO. 90-233B DATE: 06/11/90

AGG. #	90-233	90-232	90-231
TYPE:	COARSE	INTER.	WASH-F
SOURCE:	CM0253	CM0253	CM0253
% USE:	16	62	22

	TYPE	SOURCE	PERCENT	SP. GR.
GRANULATED RUBBER	C106	INTERNATIONAL RUBBER	20.0	
ASPHALT/RUBBER		INTERNATIONAL SURF.	7.0	
ASPHALT CEMENT	AC-10	SUNBELT (COOLIDGE)		1.014
MINERAL ADMIX.	II	ARIZONA PORTLAND	2.0	3.14

SIEVE SIZE	GRADATION W/O ADMIX.	GRADATION WITH ADMIX.	GRADATION SPECIFICATIONS W/O ADMIX.
3/4 IN.	100	100	100
1/2 IN.	95	95	
3/8 IN.	90	90	75 - 90
1/4 IN.	56	57	40 - 60
#4	36	37	
#8	23	25	15 - 25
#10	22	24	
#16	19	21	
#30	14	16	
#40	11	13	5 - 15
#50	7	9	
#100	3	5	
#200	2.2	4.1	0 - 2.5

AGGREGATE PROPERTIES:
% ABRASION AT 100 REV = 4, AT 500 REV = 19.
SAND EQUIVALENT: 60, CRUSHED FACES: 80.

SPECIFIC GRAVITIES: (O.D.)	COARSE	FINE	COMBINED	WATER ABS.
	2.545	2.593	2.562	1.25 %

MIX PROPERTIES (AT 7.0% ASPHALT/RUBBER)

STABILITY	1376
FLOW	11
AIR VOIDS	3.5
V.M.A.	18.2
ASPHALT ABSORP.	0.50
BULK DENSITY	141.0
MAXIMUM DENSITY	146.1

REMARKS ON DESIGN:
THIS DESIGN REQUIRES A MINIMUM OF 20.0% GRANULATED RUBBER BE ADDED, BY WEIGHT, TO THE ASPHALT CEMENT.

APPROVED

AGGREGATE SAMPLES:

LAB #	TYPE	FROM	DATE	SOURCE	1"	3/4"	1/2"	3/8"	1/4"	#4	#8	#40	#200
90-233	COARSE	STOCKPILE	05/18/90	CM0253	100.0	100.0	71.0	38.0	11.0	6.0	2.0	1.0	0.80
90-232	INTER.	STOCKPILE	05/18/90	CM0253	100.0	100.0	100.0	100.0	52.0	22.0	7.0	4.0	2.50
90-231	WASH-F	STOCKPILE	05/18/90	CM0253	100.0	100.0	100.0	100.0	99.0	95.0	85.0	36.0	1.50

AGGREGATE SOURCES:
SOURCE NO: CM0253 DESCRIPTION: T.P.#1.

SPECIFIC GRAVITY TEST(S):

TEST #	TYPE	SOURCE NO.	OD SP. GR.	SSD SP. GR.	WATER ABSORPTION	USED IN DESIGN?
1	FINE	CM0253	2.593	2.618	0.95 %	YES
1	COARSE	CM0253	2.545	2.581	1.41 %	YES

MARSHALL TESTS:

TEST #	METHOD	DATE	% ASPHALT	%ADMIX	BULK DENSITY	STABILITY	FLOW	VMA	VOIDS	USED IN DESIGN?
1	MECH	06/08/90	7.0	2.0	141.0	1376	11	18.2	3.5	YES

RICE TESTS: (WITHOUT ADMIXTURE)

TEST #	DATE	% ASPHALT	MAXIMUM DENSITY	EFFECTIVE SP. GR.	USED IN DESIGN?
1	06/08/90	7.0	145.8	2.595	YES

APPENDIX G

REPORT ON COMPARISON OF NUCLEAR DENSITY GAGES

11/2/90

A COMPARISON STUDY OF PAVEMENT DENSITY MEASURING DEVICES

INTRODUCTION

As part of a project under State Highway Research Program (SHRP) in Arizona called SPS-5, a test pavement section was constructed in April 1990 on the east bound direction of Interstate 8 highway from milepost 151.15 to 160.86. After the project was paved, an experiment was performed using four types of nuclear density gauges. The objective of the experiment was two fold: first, to investigate how the different density gauges compare among themselves and with the laboratory test results, and second, to examine how directional placement of device's base plate affect the density mesurement.

The density devices were: Troxler Model 4545 (Continuous), Troxler Model 4640B (Thin Lift), Troxler 3411B (ADOT Standard), and C-200 (Contractor's gauge). All four gauge types are capable of measuring the pavement density without destroying the pavement. The Troxler's gauge 4545 is different from the other three gauge types in a way that it is capable of taking continuous readings at specified interval as it moves forward. Other three devices are of discrete type in a sense that they need to be manually placed at individual locations for taking density measurements..The discrete type gauges can be used to take several readings at each density measuring location by changing the directional placement of the base plate. The Arizona Department of Transportation (ADOT) uses Troxler's gauge 3411 and as a practice takes two density measurements at each measuring location.

APPROACH

The test section was a 12 ft. wide and 500 ft. long roadway lane. The existing roadway was milled and new lifts of pavement was overlaid and compacted, following which density measurements were taken using four different gauge types. Density measurements were taken at the right wheel path, which was defined 3 ft. inside of the outside lane mark. Only the continuous type gauge T-4545 took density readings on both left and right wheel paths. To make a valid comparison between the gauges it was necessary to consider only the right wheel path readings of the gauge 4545. For discrete-type gauges namely Troxler 4640B, ADOT Standard 3411, and Contractor's C-200, ten density-measuring locations were marked on the right wheel path at random interval. For the continuous type gauge 4545, reading interval was fixed at 50 ft., but it was randomly run six times, taking 10 readings per run, going forward (or east) and backward (or west) on the right wheel path. It was also run six times for sixty readings on the left wheel path. The Troxler 4640B took four readings per location, base plate pointing forward, left, backward, and right, making a total of 40 density readings. The gauge 3411 took two readings per location, one pointing forward and the other pointing backward, making a total of 20 density readings. The other discrete gauge C-200 took three readings per location, pointing forward, left and backward, making a total of 30 density readings. These nuclear gauge density readings along with the density estiates obtained from laboratory tests on the core samples are presented in TABLE 1.

It may be mentioned here that the above method of data collection may have some degree of locational bias since the continuous gage T-4545 was not tested exactly on the same locations as the other three devices.

FINDINGS

A summary of density data analysis is presented in TABLE 2. From the table it is evident that the gauge that ADOT uses (T-3411B) has lowest variability in density readings and thus produced a tighter confidence interval on the mean value compared to other discrete-type gauges, with a relatively small number of observations.

The density data was further analyzed statistically to make several comparisons. The follwing conclusions were drawn:

1) The differences in mean density values obtained from four gauge types were not significant (p-value for the F-test was 0.7498). Or in other words, all four gauge types produced similar results.

2) The mean density values obtained from gauge measurements and mean density value obtained from laboratory test results of the core samples were also similar. This implies that all four gauges produced reliable density measurements.

3) The thin-lift gauge 4640B was consistent between its four directional readings. This mean that the differences between the mean density values obtained from four directional readings were not significant.

4) The gauge C-200, which was used by the project contractor, was also consistent between its three directional readings, which mean that average density value was not significantly affected based on directional placement of the base plate.

TABLE - 1 Density readings using nuclear density gauges.

Gauge Type	Wheel Path	Measuring Location	Density Readings (in Pcf) 1	2	3	4	5	6
T-4545	Right	1	134.5	139.1	138.5	138.6	137.7	139.1
T-4545	Right	2	140.9	139.5	138.1	139.8	142.6	138.6
T-4545	Right	3	137.7	138.6	137.6	139.5	141.4	140.4
T-4545	Right	4	136.7	138.0	138.8	141.7	136.7	139.5
T-4545	Right	5	136.5	140.8	136.9	140.4	137.9	141.1
T-4545	Right	6	139.3	136.1	139.0	137.7	140.1	140.8
T-4545	Right	7	141.2	138.0	-	140.8	140.1	138.5
T-4545	Right	8	139.0	139.3	139.1	140.8	138.3	140.8
T-4545	Right	9	138.1	138.1	138.5	140.8	141.1	141.1
T-4545	Right	10	139.7	140.6	-	140.7	137.3	138.7
T-4640B	Right	1	137.5	140.5	139.5	140.5		
T-4640B	Right	2	138.3	138.5	138.8	139.2		
T-4640B	Right	3	138.2	139.4	139.4	136.8		
T-4640B	Right	4	137.3	138.7	139.1	139.3		
T-4640B	Right	5	138.4	139.2	139.3	141.4		
T-4640B	Right	6	138.3	138.8	138.4	139.4		
T-4640B	Right	7	135.8	137.7	135.9	135.2		
T-4640B	Right	8	141.5	142.1	142.4	143.3		
T-4640B	Right	9	135.6	137.3	135.7	137.4		
T-4640B	Right	10	140.4	139.2	140.1	141.7		
T-3411B	Right	1	138.5	139.3				
T-3411B	Right	2	138.1	138.3				
T-3411B	Right	3	138.2	138.7				
T-3411B	Right	4	140.8	140.4				
T-3411B	Right	5	139.8	138.1				
T-3411B	Right	6	137.8	138.9				
T-3411B	Right	7	136.9	137.4				
T-3411B	Right	8	138.1	138.3				
T-3411B	Right	9	139.5	140.4				
T-3411B	Right	10	139.4	138.8				
C-200	Right	1	136.1	137.3	135.3			
C-200	Right	2	138.9	140.4	138.7			
C-200	Right	3	135.6	135.5	135.9			
C-200	Right	4	141.2	138.9	139.1			
C-200	Right	5	137.0	136.8	137.7			
C-200	Right	6	142.4	142.1	142.1			
C-200	Right	7	140.9	137.1	138.8			
C-200	Right	8	139.1	139.6	139.6			
C-200	Right	9	140.3	138.4	138.8			
C-200	Right	10	138.8	138.7	138.5			

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TABLE - 1 (Continued).

Gauge Type	WHeel Path	Measuring Location	Pavement Density Readings (in Pcf) 1st	2nd	3rd	4th	5th	6th
T-4545	Left	1	138.7	136.8	139.3	140.3	139.6	142.6
T-4545	Left	2	138.6	138.7	139.7	137.5	141.4	138.7
T-4545	Left	3	137.8	136.1	137.8	139.7	142.9	137.9
T-4545	Left	4	138.5	139.4	138.2	139.1	139.9	137.1
T-4545	Left	5	140.1	139.1	138.5	138.9	143.0	140.0
T-4545	Left	6	138.0	141.6	137.5	138.5	138.7	139.5
T-4545	Left	7	136.2	140.1	137.2	139.7	139.8	138.1
T-4545	Left	8	140.2	139.1	139.8	139.3	140.8	141.4
T-4545	Left	9	138.7	139.3	140.2	136.9	137.4	139.9
T-4545	Left	10	140.6	137.0	140.1	139.6	139.8	135.7
LAB	Right	1	141.2					
LAB	Right	2	139.4					
LAB	Right	3	135.6					
LAB	Right	4	139.2					
LAB	Right	5	140.6					
LAB	Right	6	141.0					
LAB	Right	7	138.1					
LAB	Right	8	139.6					
LAB	Right	9	137.1					
LAB	Right	10	136.3					

CORRECTION FACTORS FOR GAUGES:

Troxler 3411B: +2.4 pcf
Troxler 4545: +1.7 pcf
Troxler 4640B: +2.4 pcf

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TABLE - 2 Summary of nuclear gauge density data.

Gauge Type	Sample Size	Average Density (pcf)	Standard Deviation	Standard Error	95% Confidence Interval for Mean
T-4545	58	139.1517	1.6058	.2109	138.7295-139.5739
T-4640B	40	138.8875	1.9201	.3036	138.2734-139.5016
T-3411B	20	138.7850	1.0317	.2307	138.3021-139.2679
C200	30	138.6533	1.9783	.3612	137.9146-139.3920
LabTest	10	138.8100	1.9683	.6224	137.4020-140.2180
Total	158	138.9221	1.7212	.1369	138.6517-139.1926

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APPENDIX H

COST ANALYSIS OF DIFFERENT REHABILITATION STRATEGIES IN SPS-5

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1				SHRP	SPS-5	INITIAL	NSTRUCTION		COST	ANALYSIS		STATE	ESTIMATE		
2						RIGHT	LANE	ONLY							
3															
4															
5		TEST	ASPHALT	CEMENT				MINERAL	ADMIXTURE		ASPHALT	CONCRETE			EXTENDED
6		SECTION													TOTAL ($)
7			QUANTITY	NIT PRIC	TOTAL ($)		QUANTITY	NIT PRIC	TOTAL ($)		QUANTITY	NIT PRIC	TOTAL ($)		
8															
9		40507	42.817	130	5566.21		17.0232	90	1532.088		911	12	10932		18030.3
10															
11		40504	20.868	130	2712.84		8.296706	90	746.7035		444	12	5328		8787.544
12															
13		40503	31.535	130	4099.55		8.608564	90	774.7708		901	10	9010		13884.32
14															
15		40508	29.26	130	3803.8		7.987525	90	718.8772		836	10	8360		12882.68
16															
17		40509	19.985	130	2598.05		5.455594	90	491.0035		571	10	5710		8799.053
18															
19		40502	8.19	130	1064.7		2.235743	90	201.2168		234	10	2340		3605.917
20															
21		40506				NO		DATA							
22															
23		40505	8.836	130	1148.68		3.51302	90	316.1718		188	12	2256		3720.852
24															
25		40510	14.194	130	1845.22		5.643255	90	507.8929		302	12	3624		9566.77
26		INVERTED	9.695	130	1260.35		2.646584	90	238.1926		277	10	2770		
27															
28		40511	10.22	485	4956.7		2.662353	90	239.6118		146	27	3942		9138.312
29															
30		40501	0	0	0		0	0	0		0	0	0		0
31		CONTROL													

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1				SHRP	SPS-5	INITIAL	NSTRUCTION		COST	ANALYSIS		BID	PRICE		
2						LEFT	LANE	ONLY							
3															
4															
5		TEST	ASPHALT	CEMENT				MINERAL	ADMIXTURE		ASPHALT	CONCRETE			EXTENDED
6		SECTION													TOTAL ($)
7			QUANTITY	NIT PRIC	TOTAL ($)		QUANTITY	NIT PRIC	TOTAL ($)		QUANTITY	NIT PRIC	TOTAL ($)		
8															
9		40507	38.023	128	4866.944		15.1172	90	1360.548		809	11.35	9182.15		15409.64
10															
11		40504	18.565	128	2376.32		7.381078	90	664.2971		395	11.35	4483.25		7523.867
12															
13		40503	13.125	128	1680		3.582921	90	322.4629		375	11	4125	PARTIAL	6127.463
14															
15		40508	8.26	128	1057.28		2.254851	90	202.9366		236	11	2596	PARTIAL	3856.217
16															
17		40509	8.085	128	1034.88		2.207079	90	198.6371		231	11	2541	PARTIAL	3774.517
18															
19		40502	6.335	128	810.88		1.729356	90	155.6421		181	11	1991		2957.522
20															
21		40506	13.489	128	1726.592		5.362961	90	482.6665		287	11.35	3257.45		5466.708
22															
23		40505	5.358	128	685.824		2.130235	90	191.7212		114	11.35	1293.9		2171.445
24															
25		40510	11.092	128	1419.776		4.409961	90	396.8965		236	11.35	2678.6		4746.6
26		INVERTED	6.58	128	842.24		1.796238	90	161.6614		188	11	2068		
27															
28		40511	12.6	674	8492.4		3.282353	90	295.4118		180	45	8100		16887.81
29															
30		40501	0	0	0		0	0	0		0	0	0		0
31		CONTROL													

SPS5$LS.XLS

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1				SHRP	SPS-5	INITIAL	NSTRUCTION		COST	ANALYSIS		STATE	ESTIMATE		
2						LEFT	LANE	ONLY							
3															
4															
5		TEST	ASPHALT	CEMENT				MINERAL	ADMIXTURE		ASPHALT	CONCRETE			
6		SECTION													EXTENDED
7			QUANTITY	NIT PRIC	TOTAL ($)		QUANTITY	NIT PRIC	TOTAL ($)		QUANTITY	NIT PRIC	TOTAL ($)		TOTAL ($)
8															
9		40507	38.023	130	4942.99		15.1172	90	1360.548		809	12	9708		16011.54
10															
11		40504	18.565	130	2413.45		7.381078	90	664.2971		395	12	4740		7817.747
12															
13		40503	13.125	130	1706.25		3.582921	90	322.4629		375	10	3750	PARTIAL	5778.713
14															
15		40508	8.26	130	1073.8		2.254851	90	202.9366		236	10	2360	PARTIAL	3636.737
16															
17		40509	8.085	130	1051.05		2.207079	90	198.6371		231	10	2310	PARTIAL	3559.687
18															
19		40502	6.335	130	823.55		1.729356	90	155.6421		181	10	1810		2789.192
20															
21		40506	13.489	130	1753.57		5.362961	90	482.6665		287	12	3444		5680.236
22															
23		40505	5.358	130	696.54		2.130235	90	191.7212		114	12	1368		2256.261
24															
25		40510	11.092	130	1441.96		4.409961	90	396.8965		236	12	2832		4746.6
26		INVERTED	6.58	130	855.4		1.796238	90	161.6614		188	10	1880		
27															
28		40511	12.6	485	6111		3.282353	90	295.4118		180	27	4860		11266.41
29															
30		40501	0	0	0		0	0	0		0	0	0		0
31		CONTROL													

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1				SHRP	SPS-5	INITIAL	NSTRUCTION		COST	ANALYSIS		BID	PRICE		
2						RIGHT	LANE	ONLY							
3															
4															
5		TEST	ASPHALT	CEMENT				MINERAL	ADMIXTURE		ASPHALT	CONCRETE			EXTENDED
6		SECTION													TOTAL ($)
7			QUANTITY	NIT PRIC	TOTAL ($)		QUANTITY	NIT PRIC	TOTAL ($)		QUANTITY	NIT PRIC	TOTAL ($)		
8															
9		40507	42.817	128	5480.576		17.0232	90	1532.088		911	11.35	10339.85		17352.51
10															
11		40504	20.868	128	2671.104		8.296706	90	746.7035		444	11.35	5039.4		8457.208
12															
13		40503	31.535	128	4036.48		8.608564	90	774.7708		901	11	9911		14722.25
14															
15		40508	29.26	128	3745.28		7.987525	90	718.8772		836	11	9196		13660.16
16															
17		40509	19.985	128	2558.08		5.455594	90	491.0035		571	11	6281		9330.083
18															
19		40502	8.19	128	1048.32		2.235743	90	201.2168		234	11	2574		3823.537
20															
21		40506				NO		DATA							
22															
23		40505	8.836	128	1131.008		3.51302	90	316.1718		188	11.35	2133.8		3580.98
24															
25		40510	14.194	128	1816.832		5.643255	90	507.8929		302	11.35	3427.7		9566.77
26		INVERTED	9.695	128	1240.96		2.646584	90	238.1926		277	11	3047		
27															
28		40511	10.22	674	6888.28		2.662353	90	239.6118		146	45	6570		13697.89
29															
30		40501	0	0	0		0	0	0		0	0	0		0
31		CONTROL													